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CATARACT EXTRACTION

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BY

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PREFACE

THE writing of this book has been laboured and slow. The volume embodies an experience of about five thousand extractions. This is a comparatively small experience for an ophthalmic surgeon of standing in India. But on this account the material has been, perhaps, more completely handled and investigated than if the numbers had been larger. In busy seasons Indian surgeons have barely time to perform their operations, and can see little or nothing of the cases afterwards. For years I have jotted down facts and ideas regularly as they came, and have developed them for teaching purposes, both in hospital and in the lecture theatre. The present work has, in a sense, grown out of an earlier publication—'The Practical Details of Cataract Extraction'—of which two editions were published in 1903. A large portion of Chapter I, and a few isolated paragraphs and sentences elsewhere, have been taken with little or no change into the new publication. But for the most part this larger effort consists of new material collected from a wider experience. An attempt has been made to present an up-to-date treatise, as complete as desirable from a practical point of view, and likely to be of service even to older surgeons who may have already formed their opinions and established their procedure. The historical side of the subject has alone been very imperfectly dealt with.

NOTTINGHAM,
June, 1908.

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ERRATA

Page 104, line 4, delete the article at the beginning of the line.
Page 107, line 8, *for* "is" *read* "was."
Page 120, line 29, *insert* "is made" *after* "counter-pressure."
Page 124, line 10, *for* final "by" *read* "of."
Page 140, line 19, *for* "is" *read* "are."
Page 142, footnote, *for* "adopted" *read* "adapted."
Page 203, line 8, *for* "cubic millimetres" *read* "centimetre."
Page 227, last line, *for* "nuclei" *read* "nucleus."
Page 232, line 3, *for* "Von" *read* "Van."
Page 237, line 34, *for* "overripes" *read* "overripe."

Also a few 'split infinitives' have escaped detection

CATARACT EXTRACTION

CHAPTER I

OPERABLE CATARACT

Definitions—Progressive cataracts—Stages—Varieties—Liquefying, shrinking, and hypersclerotic cataracts—Complicated and traumatic cataracts—Operability—Artificial ripening—Volume of cataractous lenses.

THE term 'cataract' denotes opacity of the crystalline lens. Its nature and varieties will be entered into here only so far as appears necessary from their bearing on treatment. The term 'capsular cataract' does not ordinarily indicate loss of transparency of the true capsule of the lens. It is applied to proliferations of the lens cells which normally line only the anterior capsule, but which, in some cataractous lenses, may extend around over the whole of the posterior capsule also. The new formations are within the true capsule, but are inseparable from it. 'After-cataract'—also spoken of as 'secondary cataract,' thus unnecessarily introducing confusion with cataract secondary to other diseases of the eye—is the opacity which frequently interferes with vision after the removal of the lens. It may be capsular cataract in the above sense, or even possibly opacity of the true capsule, or there may be opaque cortex left imprisoned between the layers of capsule. The name is also less correctly applied to deposit on the front of the capsule—*i.e.*, strictly speaking, pupillary membrane.

The cataract may be partial, affecting only portions of lens substance, or general. Completeness, or a near approach to it, is considered generally necessary for treatment by extraction of the lens, which is almost the only recognized measure* nowadays for lenses with hard nuclei, absorption of opaque lens matter being practicable in young persons with lenses still soft throughout.

Progressive Cataracts, those which become general or complete, are classified thus:

I. **Primary,** independent of other recognizable affection of the eye. This includes by far the largest group, the purely idiopathic cases, mostly senile, yet occurring at any age. Senility in this connexion is in India a very relative term, since the cases begin to be numerous after forty years of age.† There are also the cataracts developing in diabetes, nephritis, tetany, and ergotism, and glass-blower's and bottle-finisher's cataract.

II. **Complicated,** or **secondary** to obvious disease of the eye—*e.g.*, in high myopia with disease of the vitreous and choroidal changes, and in late stages of retinitis pigmentosa. Or due to advanced glaucoma, or to the effects of irido-cyclitis, atrophy of ciliary body, and posterior synechiæ. Or a result of dislocation of the lens.

III. **Traumatic,** due to penetrating wound, or to rupture of the capsule.‡ With these may be grouped the

* Depression and reclination of cataracts, still very frequently performed by *vaids* and *hakims* in India, may in very rare instances be the only treatment available.

† It is not true, however, of Bombay that "the majority of cataract patients come to operation at forty years or thereabouts" (Hirschberg, speaking of the East Indies generally, quoted in Norris and Oliver's 'System,' iv. 324). In Bombay there are, roughly speaking, twice as many patients over fifty as under fifty years of age. Probably in the intense heat and glare of the northern plains of India cataract comes earlier.

‡ The few traumatic cataracts recorded without evident rupture of capsule have been partial, and in some cases transient.

lenses needled preparatory to removal in high myopia, or for lamellar cataract, etc.

The **Stages** into which it is convenient to divide the development of cataract are: (1) Incipient, (2) unripe, (3) ripe or mature, and (4) overripe. Cataracts are much more often allowed to become overripe in India than in Europe. It may be roughly stated that in the *incipient* stage they often require a dilated pupil or dark room examination for their certain detection—for their distinction, for instance, from simple senile sclerosis. *Unripe* cataracts are at once recognizable with the naked eye, but there is still some transparent or semi-transparent cortical matter remaining. In the *ripe* stage the whole lens looks opaque. *Overripeness* is shown by certain secondary changes, and by the formation of capsular opacities, recognizable by being whiter than any superficial opacity of lens substance.

The term 'ripeness,' indicating complete opacity of the lens, implies also that the whole lens can be removed from its capsule easily, "like a ripe fruit out of its shell," and that the cataract is therefore ready for operation. The term is still retained to denote the fullness of the cataractous change, though it has long been recognized that many lenses are fit for removal while still preserving much of their transparency. According to Hirschberg,* this style of indicating the stage of the cataractous process originated before the operation of extraction was known —at a time, therefore, when lenses were merely depressed.

The **Varieties** of cataract formation are not so clearly separable, combinations and connecting-links serving to fill in gaps between the different typical degenerations. And attempts which have been made to classify cataracts from clinical appearances alone have led to some confusion, owing to failure to distinguish between stages and

* *Cbl. f. pr. A.*, xiv (1890), 210.

processes. Yet clinical grouping is decidedly useful to indicate important practical differences in the shape and size of the lens, and in the consistence and cohesion of its substance, and in the elasticity and toughness of the capsule.

A sufficiently clear distinction has not been maintained between the processes at work in senile cataract formation. Three main types of change are clearly recognizable—the first progressing through liquefaction towards ultimate absorption; the second leading, by slow shrinkage of the lens, to the formation of a more or less flattened disc enclosed in very opaque capsule; the third forming the comparatively uncommon black cataract. These divisions are the same as those made by A. Graefe* in 1884, but they read differently, because he did not follow the changes in their various stages.

I. **Liquefying Cataracts.**—We have been long familiar with the changes which, in traumatic cataract, follow from the simple admission of aqueous through a rent or cut in the capsule. Bluish-white opacity, swelling, softening, breaking down and disappearance of non-sclerosed lens substance takes place.

In many idiopathic cataracts similar changes are so early and pronounced that they constitute the main clinical features. But the fluid which gains an entrance, and in which the broken-down cortex is suspended, remains for long unabsorbed. It does not disappear rapidly, as in traumatic cataract, where the opening in the capsule precludes an accumulation of fluid contents.

It seems that the admission of aqueous may be due to degeneration of the capsular epithelium, for similar changes are brought about in Förster's ripening of cataracts by trituration of the lens, which trituration has been shown

* *A. f. O.*, xxx. 4, 211.

(in rabbits) to result primarily in breaking down of the epithelial cells. And in some advanced stages of this form of cataractous degeneration complete disappearance of the cells lining the capsule has been observed.

The incipient stage of each variety of cataractous change does not concern us here. In the typical *unripe* lens of this class the anterior chamber is frequently shallowed, owing to swelling of the lens, and possibly also to an alteration in the shape of the lens. It may become more nearly spherical by distension of the capsule and softening of the contents. The rounded apices of opaque bluish-white glistening sectors of varied breadth are seen within the normal pupil, separated by a little clear cortex. Since the opacity affects the superficial fibres of the lens, the iris throws no shadow. There are other cases less typical, in which the anterior chamber is less often shallow, and the soft cortical matter is uniformly clouded and dull.

The *ripe* stage of this form of cataract appears to be a short one, as it is not very frequently seen.

In the *overripe* stage there is definite liquefaction, at first of the superficial cortex only, but soon involving the deeper cortex, and eating away more or less of the nucleus also. Thus we get the *Morgagnian* cataract, with nucleus floating free in milky fluid. The nucleus may be small, transparent, and amber-coloured, or larger, dark, and opaque. The capsule is either quite transparent, or there is faint diffuse opacity only, or this with numerous small brilliantly white dots.* The opacity may be limited to the anterior capsule or may extend more or less over the posterior portion also. The anterior chamber may still

* These discrete opaque points were found exclusively in our practice in Morgagnian cataracts, and in lenses which had passed through the Morgagnian phase. Occasionally some capsular opacity develops early, when the cataract is barely mature.

be shallow, and actual measurements taken in Bombay show that some Morgagnian lenses are above the normal in volume. But absorption of the milky fluid tends to gradually progress until nothing remains but the nucleus in the collapsed capsule. Very rarely the nucleus disappears entirely, in adults beyond middle age, while the sac is still distended with fluid. The fluid then has a creamy tint. In India the overripe stage of congenital or infantile cataract is not rarely seen in children as a thin layer of milky fluid in an opaque flattened sac. In adults some of the very overripe lenses have still quite transparent capsules, others opaque. Some become tremulous, others do not. Those without tremor are not clinically recognizable through the undilated pupil. The capsule having retracted away from the iris, a narrow space is left through which a shadow may be cast by the iris. In our practice the nature of the cataract was sometimes not known till an iridectomy had been made during operation, revealing a dark space above the shrunken nucleus.

Opaque capsules are not only thickened and toughened, and therefore difficult to cut during operation, but are also inelastic. The edges of any opening made in the membrane at the time of the cataract extraction or later tend to come together again.

Apart from these shrunken overripe lenses and from subluxated lenses, marked tremor of the lens may be taken to indicate possibly both fluidity of vitreous and atrophy of zonule. In the cases now dealt with there may be no noticeable softening of the vitreous, and, where liquefaction is present, the change may be confined quite to the anterior portion of the humour, and may, perhaps, be explained by the repeated impact of the shaking lens. Atrophy of the zonule is commonly assumed also, but I do not know upon what grounds. The tremor is sufficiently explained by the loose state of the almost empty and inelastic capsule. I have a strong impression that in the cases where only the nucleus remains in the

sac, and where yet the lens is not tremulous, the capsule is always, or at least generally, transparent, and therefore presumably still elastic. In the overripe stage of the second variety of cataract formation mentioned above—the shrunken disc—there is, according to our experience, never any tremor. These lenses have not passed through any swollen stage, during which the elasticity of the capsule might have become reduced by over-distension.

II. **Shrinking Cataracts.**—In most cataracts at a very early stage, and in many throughout their whole course, there is no evidence of an excess of fluid within the lens. On the contrary, when the degeneration is well advanced, the cortex is distinctly firmer and apparently drier* than normal. A slow progressive reduction in size takes place. Priestley Smith showed that in incipient cataract the lens is commonly reduced in bulk. In the later stages the shrinkage is often very striking. In patients of middle age and under, in whom nuclear sclerosis is not very advanced, the shrinkage tends to be especially noticeable antero-posteriorly.

It may be stated generally that this progressive loss of substance and loss of transparency—this evidence of defective nutrition of the lens as a whole—may pass through its whole course uncomplicated; but it is liable to be modified at any stage by the addition of changes recognizable as due to the admission of fluid, indicating probably, as above stated, diminished resistance of the subcapsular cells. Thus the frequent blending of the two types, rendering rigid classification impossible.

The typical *unripe* cataracts seen through the pupil have usually a diffused greenish appearance, perhaps tinged with olive from nuclear sclerosis. In a few cases the opacity is greyish, but is then quite deep—nuclear or

* This may be shown in the staining and decolouring of microscopical sections.

perinuclear. There is a quantity of perfectly clear cortex, through which a very distinct shadow is thrown by the iris. This deep central uniform cloudiness may remain with but little change for years, affecting vision greatly from its position, but remaining quite unfit for operation. In other eyes the (greenish) opacity comes well up to the iris, but it is so slight that a faint shadow is transmitted from the iris through the superficial layers of the lens. The transparent appearance of such a lens after removal is remarkable; there may or may not be a small central haze or cloud of opacity noticeable (after removal). The superficial layers, though so clear, are fairly firm and coherent, and shell out easily entire.

In the *ripe* stage these lenses vary considerably in size and appearance. The diminution in size, especially in thickness, varies inversely with the degree of nuclear sclerosis, and therefore to a large extent with the age of the patient. A broad thick disc may result, with sharp edge; but more frequently the contraction is lateral as well as antero-posterior. The nucleus ranges from opaque white or cream-coloured in a few rather young lenses with defective sclerosis, through the average smoky brown, to the larger dark hypersclerotic nucleus. The lenses with whitish nucleus may appear perfectly ripe clinically, while on extraction the equatorial rim of cortex may be found quite or nearly transparent. This thin transparent or translucent rim is, however, firm, and separates whole from the capsule. In other lenses the distinction between nucleus and cortex is not very evident; the loss of transparency seems uniform throughout, but very incomplete. There may be fine superficial radial slits or cracks on the anterior surface.

The *overripe* lens is remarkable for its flattened discoid shape, and often for its small size; also for the amount

of capsular thickening and opacity that develops, often with a large anterior central untearable patch, possibly containing lime deposits. What remains of the cortex consists chiefly of a broad equatorial ring, cream-coloured and coherent, but separating readily from the nucleus. The latter varies in size and colour, as in Morgagnian cataracts, but it is commonly rather larger and less clear.

Its colour is seen clinically through the scanty remains of anterior cortex. Very rarely the nucleus may have disappeared, only scanty cheesy cortex remaining.

III. The third variety of cataract formation is a very slow **hypersclerosis**—pathological excess of the normal nuclear sclerosis—by which almost the whole lens may become hard, dark, and considerably opaque. It is relatively common in myopic eyes. In pure hypersclerosis the colour attained is finally pure black, after passing through a brownish-red tint, which, however, appears muddy only as seen through the pupil clinically. These lenses are always large, but an exact comparison of their volume with the normal at given ages yet remains to be made. Since there may be always a trace of normal cortex at the surface, capsular opacity is very rarely present. Vision commonly remains equal to the counting of fingers at a foot or more from the eye—at least, with dilated pupils—long after the cataract is ready for extraction. At any stage of the sclerosis the unaffected cortex may undergo the ordinary grey degeneration, resulting in one of the mixed forms of cataract.

In possibly half the primary cataracts seen in Bombay the second form of change persists alone. There is progressive shrinkage and opacification. There may be abnormal proliferation of lens cells, producing dense capsular opacities, but little or no excess of fluid enters the lens. Taking the final results only, Morgagnian

cataracts are much commoner than overripe cheesy discs; but this represents the greater rapidity, rather than greater frequency, of the liquefying process. A very late combination may rarely be seen in an overripe cataract, partly fluid, but containing also a coherent equatorial ring of cortex. An earlier combination is sometimes clearly seen in fairly young patients—well-marked whitish nuclear opacity, together with ripe, soft, flaky cortex.

On rare occasions the two types of degeneration may be seen in the one patient—typical shrinking cataract in one eye, liquefying in the fellow eye.

Duration of the Changes.—The most rapid formations are the swollen liquefying ones, as, indeed, one expects from a slight acquaintance with traumatic cataract. In a month a great change may take place in such lenses. To go to the opposite end of the scale, we have the deep central haze and hypersclerosis, both extremely slow, perhaps changing very little in the course of several years. To formulate a rough-and-ready rule, one may say: the deeper the opacity, the slower it will be; the more superficial the change, the faster it will progress.

COMPLICATED AND TRAUMATIC CATARACTS.

In the incipient cataract of advanced chronic glaucoma a central haze is very often the only form of opacity. Cataract secondary to choroidal and vitreous changes is apt to remain long limited to the posterior surface. Incipient cataract, developing in a highly myopic eye, is classed as secondary if there be disease of the vitreous; it may be of very slow formation. When too advanced to allow the fundus to be seen, a limitation of the field of projection would suggest detachment of the retina, especially if the tension of the eye were low, and would contra-

indicate operation. Traumatic cataract uncomplicated with severe irido-cyclitis affords the purest type of the swelling, liquefying degeneration. The result differs from that of primary liquefying cataract, in that more ready means of absorption is provided for broken-down lens substance; but the soft plentiful incoherent cortex, and the swelling of the lens are the same in both. It stands in direct contrast with some of the shrinking cataracts, where the opacity may be at first entirely deep, and where the evidences point to a lack of moisture rather than to an increase of it.

OPERABILITY.

The question with which we are immediately concerned is whether a progressive cataract is fit for extraction or not. The rule in the Cowasjee Jehangir Hospital is to insist on three ~~local~~ conditions only, with moderate general health.

1. *The cataract must be ripe enough.* Complete maturity is not required in either of the types of cataract formation. The shrinking lenses with cortex firmer than normal are often fit for operation when the patient can count fingers four or five feet distant. Immaturity entails an iridectomy as part of the operation (a preliminary iridectomy in Critchett's practice), a full-sized incision, and very slow expression of the lens. The very shallow anterior chamber found with some unripe swollen lenses constitutes a difficulty, but not a serious one.

Schweigger* and Hirschberg† pointed out that incompletely opaque lenses could be removed satisfactorily from the eyes of old people. Schweigger found that certainly after sixty years of age, and possibly a little earlier, operation might be indicated while the greater part of the lens was still transparent.

* *Cbl. f. pr. A.*, xiv (1890), 206. † *Ibid.*, 210.

Hirschberg fixed the age limit even lower—at fifty years. Beyond this age the lens might be extracted as soon as the opacity troubled the patient seriously or prevented him earning a livelihood.

In Bombay we have found that the lenses fit for extraction could be distinguished by their appearance. They include many lenses with cortex only slightly opaque; but the opacity, such as it is, is quite recognizable in the most superficial layers, and is greenish in tint. These lenses have to be distinguished from others unfit for operation, though the opacity is more obvious and affects the superficial layers. In these cases the opacity is greyish in tint, and some slight swelling of the lens may be shown by an anterior chamber a little shallower than that of the fellow eye. This greyish cortex is soft and sticky, and does not separate readily from the capsule. One must expect trouble with cortex also should one operate upon a swollen lens with glistening opaque sectors, while still transparent superficial cortex is to be seen in the pupillary area between the apices of the sectors.

2. *The pupil should react well to light.* This is accepted as a nearly certain guarantee that the fundus is sufficiently sound to justify operation. Should the movement of the pupil be impaired, the tension of the eye and the projection of light in the dark room are tested. When sluggishness is due to glaucoma or optic atrophy or other fundus affection, each case must be judged on the available data. The field of projection is the main criterion, but it is often an insufficient one. More particularly where the other eye is lost or useless, one must operate if there is any reasonable prospect of obtaining vision beyond the mere perception of moving bodies, the patient being told beforehand of the uncertainty of the result.

Very occasionally a disappointing result is obtained, in spite of a previously active pupil. In highly myopic eyes testing the field of projection may afford evidence of detachment of the retina. Central choroidal atrophy is a not very infrequent source of disappointment. If considered desirable, the function

of the macular region might be shown in advance by testing the patient's ability to distinguish two small flames placed close together in the dark room.

3. *There must be no inflammation about the eye,* and no iritis or irido-cyclitis of the fellow eye. If the other eye be atrophic and tender from past destructive irido-cyclitis following perforation of the globe, it must be excised. There must be no trace of scleritis, keratitis, etc., nor any scabby skin eruption close to the eye. The conjunctiva and lacrymal passages require particular attention.

It may be broadly stated that *conjunctivitis* must be treated until there is no discharge, or, if this be not quite feasible, special precautions must be taken at the time of operation.

In India the average condition of the conjunctiva is much worse than in Europe and America. Various grades of the changes produced by chronic conjunctivitis are very common, trachomatous and otherwise. Very poor patients coming from a distance must be admitted at once or not at all, and beds cannot be spared for preliminary treatment. Thus there are constant demands for operation in the presence of more or less chronic inflammation. Experience has shown that, provided the secretion is only scanty and mucoid, scarcely any changes in the palpebral conjunctiva necessitate delay in operating. We disregard papillary roughness, thickening, scarring, minute cysts, small follicles in the fornices, and scanty remains of confluent pale, lymphoid, trachomatous tissue. Occasionally, also, we venture to admit patients with rather freer mucoid discharge and rather marked congestion of the conjunctiva. This is done, relying upon the protection which we have found to be afforded by very free perchloride irrigation of the conjunctiva before operation.

In European practice, on the other hand, the large majority of the patients' conjunctivæ are of practically normal appearance, and operation can almost always be postponed till the surgeon is satisfied with the condition. It is usual before operation to cleanse the conjunctival surface—the 'field of

operation'—merely mechanically. Or if perchloride or cyanide of mercury or other antiseptic lotion is utilized, it is in no measured and calculated systematic manner, aiming at a definite recognizable result. And it is understood that no great reliance can be placed upon either the mechanical or the chemical attempts to clear away organisms from the field. The treatment of any conjunctivitis present must therefore be very thorough before an eye can be accepted as ready for operation.

For rapidly reducing the discharge from the rough and thickened conjunctivæ with which we had to deal in India, we found nothing equal to a daily rather free douching with strong perchloride lotion (1 in 3,000). This treatment would be too severe for conjunctivæ of nearly normal appearance.

I once had to delay operation for the treatment of a conjunctival pouch, not caring to operate with such an area shut off from the action of the perchloride lotion.

The Lacrymal Passages.—Though cataract has been successfully extracted numbers of times in the presence of chronic lacyrmal disease, the risk of infection is so great that operation must be considered inadmissible whenever there is the slightest trace of discharge obtainable from the tear-sac. No patient should be admitted without pressure being made over the sac, while the puncta are exposed by separation of the eyelids. This, however, in itself is not a sufficient test, but it is possibly enough if a 'test dressing' is always applied after the patient's admission. This was all that we relied upon in Bombay. On a few occasions we have been saved from operating in the presence of unsuspected lacrymal disease by noticing a trace of discharge and moisture on the lid borders, and on the lint used, after a night's application of the dressing. By syringeing then some discharge was washed out through a canaliculus. It is doubtless safer to instil fluorescein, and to make the patient sit for three to five minutes with head bent forward. If the nose be then 'blown,' the colour should be seen on the handkerchief. If none is seen, the lacrymal syringe must be used.

Some surgeons invariably wash out the sac as a test for discharge and for obstruction of the nasal duct. Haab receives the fluid which flows from the nasal aperture in a black vessel to show turpidity. Extirpation of the sac is to be strongly

urged in all cases of dacryocystitis. After the extirpation the eye should be ready for operation in three weeks or less. If this radical treatment cannot be carried out, and if the discharge be scanty, and especially if it can be forced down into the nose by pressure on the sac, the puncta may be sealed with the galvano-cautery. Haab,* using a fine point and a current strong enough to bring it only to a faint red heat, succeeds in closing 2 or 3 millimetres of the two canaliculi temporarily only. The canaliculi can be subsequently reopened by a conical probe. Or the canaliculi may be (perhaps preferably) rendered temporarily impervious by ligature with catgut or silk, as practised by Eversbusch, Buller, and Quackenboss. Should either canaliculus have been freely slit open, these safeguards are not readily applicable. Treatment by probing and syringeing may have to be very prolonged before safety is assured.

Some operators have found that preliminary opening of the sac through the skin and packing with iodoform or iodoform gauze for some days, also filling the canthus with sterile iodoform after operation, is sufficient to preserve the wound from contamination. Doubtless considerable protection is afforded also by the subconjunctival methods of operating.

Angelucci has practised division of the canaliculi with a knife, cutting through the whole thickness of the lids, and sealing the openings by a touch with the galvano-cautery. Later he reopens the canaliculi beyond the occlusion.

In Bombay we ignored nasal obstruction from polypi and thickening of mucous membrane. In cases of ozæna the nose was simply syringed out on admission, and again shortly before operation; but cases with purulent discharge from the nose were referred for treatment. Some surgeons pay much more attention to the condition of the nose and pharynx; but it is accepted that infection of the conjunctiva from the nose by way of the lacrymal passages does not take place.

As regards corneal opacity, it may be stated that if the cornea be transparent enough in whole or in part to admit of the state of the lens and of the pupil being made out, the patient should see sufficiently well afterwards to justify operation. A pterygium, if large, may require removal, but if small, may be left.

* 'Operative Ophthalmology,' p. 58.

The state of the fellow eye may need a small precautionary attention. If the anterior chamber be very shallow, it will be wise to instil eserin, lest an attack of glaucoma be brought on by the excitement and general conditions appertaining to the operation. We had experience of a few such cases.

Very rarely a cataract may be ripe for extraction, and yet the operation may be impossible. I once had to depress the lens in each eye of a patient with extremely small corneas—a congenital defect associated with coloboma of the iris.

When one eye has been lost from profuse intra-ocular hæmorrhage complicating cataract extraction, it is a question whether reclination should not be preferred in the second eye (see Chapter III).

The possession of good sight in one eye influences the question of operation on the other eye, only in so far that it permits of waiting for complete ripeness of the cataract without serious inconvenience. The cataract must not be allowed to become hypermature, because it is then in a less favourable state for operation. After the extraction, although both eyes do not work together, there is the advantage of the larger field of vision, and the patient has the satisfaction of being provided for during the anticipated slow onset and progress of opacity in the fellow eye. It has been argued* that until our methods improve so that we can guarantee the fellow eye against loss by sympathetic ophthalmia, we have no right to operate while the fellow eye has useful vision. The improved results obtained nowadays by a number of operators show that it should be quite possible to guard against sympathetic ophthalmia, especially where patients can be kept under observation and treatment for a sufficient length of time after operation. In India, if we did not operate upon all cataracts ready for extraction, we should drive many patients into the hands of the travelling quacks.

It is almost universally held to be unjustifiable to extract cataracts from both eyes of a patient at the same time. The possible loss of both eyes is too appalling a risk to run, and the danger from mental derangement, coughing, sneezing, etc., is more serious. Operation upon one eye may show the need of special precautions in dealing with the second eye. Finally,

* See, for example, Devereux Marshall in *The Ophthalmoscope*, iv (1906).

one eye alone may after operation stand in need of atropin instillation to the full extent that the patient can bear constitutionally. The double operation is, however, still performed occasionally under the peculiar conditions of district work in India. Hansell* considers it justifiable, and even desirable, under certain circumstances.

As regards the *general health*, very little is exacted. We never refused operation on account of diabetes. A little preliminary treatment and regulation of diet appears advisable. We operated—always with good result—upon many patients with albuminuria, even with moderate œdema.† But we feared cases with anæmia and considerable œdema. We refused cases, also, of simple extreme anæmia. Asthma, emphysema, and chronic bronchitis are not contra-indications, though they predispose to prolapse of iris,‡ and more definitely in my experience to slight iritis and to hæmorrhage into the anterior chamber. Alleviation of dyspnœa and cough is, of course, desirable, and the patient cannot be kept recumbent after operation. Snellen treats a liability to constant sneezing by placing wool soaked in cocain solution within the nares. Extreme age of the patient is no bar to operation, though it imposes the need for particular care afterwards. The same may be said of insanity and of moderate degrees of epilepsy. Leprosy, also, is not a contra-indication. Absolute deafness is a minor trouble. Suppurating processes, ulcers, etc., should be cured, or at least got into a satisfactory condition, if

* *Ophthalmic Record*, December, 1903.

† We were careful always to restrict traumatism by operating with gentleness and rapidity, fearing iritis; and we sometimes operated subconjunctivally, feeling that the tissues of these eyes could offer little resistance to microbic invasion. Deutschmann saw two suppurations in seven extractions in albuminurics. The prognosis must be guarded also, on account of possible fundus lesions present.

‡ Iridectomy hence imperative in these cases.

only on account of the bare possibility of a pyæmic condition setting in and causing metastatic inflammation in the temporarily weakened tissues of the eyeball.

Operation must be deferred if there is fever, of whatever origin, or recent syphilis; also on account of menstruation or advanced pregnancy.

Age of Patients.—A few lines must be added regarding the age of the patient at which extraction becomes admissible. 'Linear extraction,' in which the lens is coaxed out piecemeal through a small incision made with a keratome, is commonly preferred whenever practicable, to the ordinary 'flap extraction,' in which the lens is expressed whole or nearly whole. The former method is applicable regularly up to thirty years of age, and frequently somewhat later, since the absence of a hard nucleus is practically assured up to this age. But in Bombay we found that nearly all patients over twenty years of age had sufficient self-control to justify ordinary extraction through a shallow flap section. The removal of the lens in bulk is commonly more complete, and is accomplished with less instrumentation and manipulation than by the linear method.

At an earlier age the length of the incision is reduced as much as possible, on account of the want of self-control displayed by the patients both during and after operation, and possibly also on account of more frequent vitreous tension. Operation is mostly required upon lenses partly or completely transparent—for lamellar cataract, or in the treatment of high myopia. Linear extraction is preceded by one or more 'needlings,' by which the lens substance is rendered cataractous and loosened from its connexion with the capsule. The extraction may be voluntary, as an expeditious alternative to slow absorption, or it may be demanded by the onset of plus tension or inflammatory reaction, excited by the swollen and disintegrating lens. Some surgeons prefer primary incomplete extraction of the transparent lens, holding that the duration of treatment is shortened, and that the reaction from retained lens matter is likely to be less than that frequently experienced when the extraction is preceded by needling.

In young children absorption by repeated needlings is aimed

at, linear extraction, or rarely removal by suction, being undertaken as a rule only under compulsion from complications arising.

Cataracts treated in infants are usually complete. The opacity must be removed as early as possible, to enable the functions of the retina and of the visual nervous mechanism to develop. At this age the shallow anterior chamber, and a difficulty in keeping the pupil dilated with the weak atropin instillations admissible, are obstacles in the way of treatment by repeated needlings; yet this treatment should be persisted in, if possible. I have practised linear extraction under the age of one year, but in one case at least I regretted it. Extraction was performed in both eyes without preliminary needling. The cataracts were rather firm and wax-like, but were removed piecemeal with the aid of irrigation. The small incisions were subconjunctival, yet both eyes were reported to have suffered from persistent low inflammatory changes afterwards. There was an interval of some weeks between the two operations, and both eyes did well while under observation. The patient had been brought from a distance, and the relations were unwilling to stay for prolonged treatment by needlings. Extraction has been considered necessary* for this form of cataract, but discissions should suffice.

THE ARTIFICIAL RIPENING OF CATARACT.

Up to thirty or thirty-five years of age discission is the method adopted for rendering transparent lens matter opaque. To be safe and sure, 'ripening,' by the admission of aqueous through an opening in the capsule, must be slow and gradual. The primary needling must be limited, lest by rapid swelling and disintegration of the lens high tension and irritation of the iris be excited. Extraction may then have to be undertaken with the posterior layers of the lens still transparent and adherent to the capsule, and with the eye congested and irritable. The extraction is incomplete, and more or less iritis frequently follows. But slow ripening by repeated needlings is very satisfactory in young subjects. (Stellwag, in 1886, tried discission of the posterior capsule.) Beyond the above-men-

* See Czermak, 'Die Augenärztlichen Operationen,' p. 1094.

tioned age experience has shown that the eye too frequently resents the needling of transparent lens matter.

It is between the ages of forty and sixty that the question of the ripening of progressive cataracts generally arises. Many surgeons apparently fix no age limit in their extractions of unripe senile cataract; but others prefer Förster's ripening by trituration of the lens under sixty years of age. An iridectomy is performed, and the lens massaged by spoon pressure through the cornea. The ripening takes from one to eight weeks, according to the condition of the lens and the duration of the massage. Sometimes the treatment has proved insufficient, and various complications have been met with—iritis, rupture of the zonule, or rarely of the capsule, and very rarely abscess of the cornea. But they all appear to be avoidable by correct procedure. Individual operators have been able to report some hundreds of successful cases free from complication. The method is held to be contra-indicated by advanced atheroma (lest glaucoma be induced), and by choroiditis or fluid vitreous, and in some marasmatic patients.

Preliminary iridectomy alone has proved effectual occasionally, but it cannot be depended upon. Massage through the cornea after simple paracentesis has been fairly satisfactory. It has been combined with puncture of the lens capsule.* Direct massage of the lens with a small spatula after paracentesis has been preferred by Ricaldi, Bettmann, and others, to Förster's method.

McKeown's and Jocq's attempts to ripen by injecting fluid within the capsule appear to have worked mainly as simple discissions.

Wolffberg† has ripened cataracts with a hot-air douche, directed upon the closed lids by means of a 'kalorisator.' With two or three applications a day maturation was accomplished in about a week. Maynard‡ thinks extraction in the capsule, as practised by Smith, often a very effective means of dealing with unripe cataract.

* Fage, *Ann. d'Ocul.*, cxxix.

† *Woch. f. Ther. u. Hygiene des Auges*, September 22 and October 6, 1904.

‡ 'Manual of Ophthalmic Operations,' Calcutta, 1908, p. 55.

THE VOLUME OF CATARACTOUS LENSES.

Some years ago I measured a few lenses in their capsules in a Priestley Smith's lens measurer, immediately after extraction. The point brought out was that some of the cataractous lenses of the liquefying type, either Morgagnian or less advanced, were distinctly swollen beyond the extreme normal limits by the imbibition of aqueous. It is unnecessary to demonstrate by measurement the reduction in size which is seen in many shrinking cataracts. The measurements are given in tabular form, together with the extreme limit and the average bulk of the normal lens at the same age, as computed roughly from Priestley Smith's table.* But it is to be noted that the average normal lens of the native of Bombay is probably appreciably smaller than that taken from Priestley Smith's measurements in England, in correspondence with the poorer average physique in Bombay.

* Reproduced in Norris and Oliver's 'System,' iv. 286.

VOLUME OF CATARACTOUS LENSES

Age of Patient.	Variety of Cataract.	Volume of Lens (c.mm.).	Maximum Limit of Normal Lens (Priestley Smith) (c.mm.).	Average Normal Lens (Priestley Smith) (c.mm.).
32	Ripe ; anterior chamber shallow	287	184	
35-40	Morgagnian ; anterior chamber rather deep. The upper margin of the (somewhat shrunken) lens was seen when the iridectomy was made	181	197	About 175 or 180
„	Morgagnian ; anterior chamber not shallow	201	„	
42	„ with most of the 'milk' absorbed ; unusually large, pale, transparent nucleus	153	199	About
45-50	Morgagnian	211	227	190
„	„ anterior chamber not shallow	189	„	
51	Slightly overripe disc	186	—	
52	Morgagnian ; opaque capsule	257	250	
50-55	Unripe greenish	225	„	About
„	Morgagnian ; anterior chamber rather shallow ; lens slightly tremulous	216	„	205
„	„ anterior chamber not particularly shallow ...	235	„	
60-65	„ anterior chamber shallow ; dark nucleus ...	296	„	About
64	Ripe ; cortex rather soft	247	„	220
„	Hypersclerosis fairly advanced, but not black...	216	„	
103	Nearly ripe ; cortex soft	282	?	?

CHAPTER II

DESCRIPTION OF THE OPERATION

Historical outline—Instruments—General arrangements—Preparation of the patient—Preliminaries—Initial steps—The combined operation—The section—The iridectomy—The opening of the capsule—The delivery of the lens—Toilet of the eye—The dressing—After-course and after-treatment.

ROUGH GENERAL HISTORICAL OUTLINE OF THE DEVELOPMENT AND PROGRESS OF CATARACT EXTRACTION.

THOUGH lenses dislocated into the anterior chamber had been removed early in the eighteenth century by St. Yves and P. du Petit, it was not till 1752 that Daviel published his method of extracting cataractous lenses from behind the iris, already tested in over 200 operations.

Holding the lower lid depressed, he punctured with a broad needle at the lower corneal margin, and enlarged the opening at either side—first with a blunt-pointed needle, and further

FIG. 1.—BEER'S KNIFE.

with curved scissors. Thus almost a semicircular flap was outlined. The anterior capsule was then simply opened with a fine lancet, or, if thickened, incised circularly and partly removed with forceps. The lens, after being loosened in its bed by the insertion of a narrow spoon between lens and iris, was delivered by pressure on the globe below, applied by the index and middle fingers through the lower lid.

The manner of cutting the section was soon improved by the introduction of the broad triangular knives of Bèranger, Beer, and others. With these a semicircular incision, placed

in clear cornea a little within the limbus, was completed in a single short thrust.

The fairly frequent suppuration of the cornea met with was attributed then to the tendency of the flap section to gape, preventing early union. Hence followed attempts to extend the application of what became known as 'simple linear extraction,' originally employed only for luxated lenses. The slightly curved wound, made with a lance-shaped knife or keratome, was made as large as possible, and by von Graefe was placed near the upper margin of the cornea and combined with an iridectomy. But even so, it was found to admit of the easy exit only of capsular, shrunken, and soft cataracts, and of lenses with small nuclei and plentiful soft cortex, readily broken up.

Critchett and Bowman (1864) increased the size of the wound, making a very shallow corneal flap section, but found it necessary to draw out the lens with the scoops which still bear their names.

Jacobson lessened the number of suppurations by the application of another principle. He returned to the lower semi-

FIG. 2.—JACOBSON'S INCISION.

circular flap, but placed it further back behind the visible corneal margin, so that it lay partly in the sclerotic. He recognized that the vascular scleral tissue was less disposed to suppuration than the non-vascular cornea. The large size and peripheral position of the wound necessitated an iridectomy to guard against the tendency to prolapse of iris.

Von Graefe in 1865 attempted to combine both safeguards against suppuration—a linear wound and scleral position.

The so-called linear extraction by incision with a keratome

FIG. 3.—JAEGER'S KERATOME.

('Lanzenextraction') is not by a truly linear incision. The latter must lie in a plane perpendicular to the surface, in a

corneal meridian, and such a section is obviously impossible with a keratome if made of any length.

In order to ensure the closest possible contact of the wound surfaces, von Graefe designed an incision approximating as closely as practicable to an arc of the largest possible circle, being, therefore, in line and plane as nearly as possible in a radius of the scleral curve. The lance knife had to be replaced by a narrow-bladed instrument for the new incision, at a considerable angle to the iris. Hence the Graefe's knife, suited for transfixion by puncture and counter-puncture, which has long survived the operation which made its value generally known. With this knife a section was made with its centre close to the upper corneal margin, but its ends some little distance away in the sclerotic. In von Graefe's original incision the points of

Fig. 4.—Von Graefe's Incision.

entry and emergence of the knife were situated a little over 1 millimetre from the cornea, and 1·5 millimetres below a tangent drawn through the summit of the corneal circumference. The plane of the section at its two ends was parallel to the iris surface, but for the rest of its extent nearly perpendicular to the surface of the globe. The knife edge had to be turned sharply forwards as soon as the globe was transfixed. This incision proving too short, it was slightly elongated and its curve increased, by lowering its ends. Its plane was thereby also a little altered, being directed more obliquely to the surface. In making the puncture the knife was always directed towards the centre of the pupil, to make the deep wound as large as possible. The position of the section necessitated the cutting of a short conjunctival flap. A large iridectomy was always made, and on this account the operation known as the 'peripheral linear,' was also known as the 'modified linear' extraction, to distinguish it from the 'simple' operation without iridectomy. The method had a great vogue for a number of years, largely replacing the old flap extraction.

Though suppuration of the wound and panophthalmitis were

largely eliminated by this new method of operating, this advantage was counterbalanced by an increase in the number of deep infective inflammations and of sympathetic disease of the fellow eye. And there were smaller drawbacks. Greater skill was required than for the flap section, and there was often trouble from hæmorrhage into the anterior chamber. The delivery of the lens through the narrow wound was often difficult. Owing to this and to the peripheral situation of the wound, loss of vitreous was not infrequent, and cystoid scars developed from inclusion of iris in the angles of the wound.

Weber* attempted to avoid gaping of the section, both such as is liable to occur in linear wounds by retraction of the wound surfaces, and also that by forward displacement of a corneal flap. He endeavoured to make an almost linear incision large enough for the delivery of hard cataracts complete, in a plane

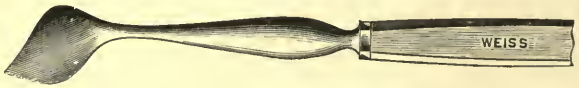

FIG. 5.—WEBER'S KNIFE.

parallel to the iris, by means of a heart-shaped keratome curved with the concavity backwards. But the section, 10 millimetres long, was not sufficient for lenses with large nuclei. The instrument, perhaps, requires notice rather than the method. Used even earlier by Santarelli (in 1795) and by Jaeger (in 1866), it is again employed at the present day by Sattler for extraction of the transparent lens in high myopia.

The feeling that Graefe's incision was too peripheral led to alterations in two directions. Many operators preserved the scleral site, but made the section more arched by lowering the ends of incision and bringing them closer to the cornea. Others preserved the linear character of the wound very largely, but, relying on antiseptic measures, displaced the section well into the cornea.

Von Arlt and his pupils—Becker, Fuchs, and others—for long practised a section scarcely at all modified from von Graefe's. The puncture and counter-puncture were 2 millimetres below the tangent of the upper margin of the cornea,

* *A. f. O.*, xiii (1867).

and lay in the tangents of the outer and inner margins, and were 1·5 millimetres from the cornea. The centre of the section was placed either a little above, or in, or a little below the corneal margin.

Horner and many others lowered the ends of the section

FIG. 6.—VON ARLT'S INCISION.

FIG. 7.—HORNER'S INCISION.

further, and thus the linear section became changed into a shallow peripheral flap section.

Liebreich's corneal section (1872) was much practised in England. It was made by preference downwards, and without iridectomy. The whole incision, including puncture and counter-puncture, was made with a very narrow Graefe's knife, inclined downwards and forwards at an angle of 45 degrees. The extremities of the wound lay in the sclerotic, 1 millimetre from the cornea and 2 millimetres below the horizontal corneal meridian. The middle of the incision fell 1·5 to 2 millimetres within the corneal circumference.

Lebrun (1872) made a shallow flap section upwards, purely corneal. The ends of the incision were 1 to 2 millimetres below

FIG. 8.—LIEBREICH'S INCISION.

FIG. 9.—LEBRUN'S INCISION.

the horizontal corneal meridian; the summit of the arch was at about the upper border of the undilated pupil. It was made with the narrow blade at an angle of about 30 degrees with the surface of the iris.

(What is known as Kuchler's section, forming a straight, horizontal line across the centre of the cornea, may be mentioned here as having been actually practised about this time.)

The flap section again came gradually into fashion, but for the

most part in slightly different form. It was now an upper flap, lying just in front of the limbus, and therefore without a conjunctival flap. De Wecker introduced his short (3 millimetres) flap in 1875. But the fear of a larger section being allayed

FIG. 10.—DE WECKER'S INCISION.

through the adoption of antiseptic and aseptic measures, and the desire for simple extraction making headway, the tendency soon became marked to enlarge the section almost or quite to the old semicircle.

Thus, the main events in the history of cataract extraction have been the changes which have taken place in the section—in its form, its site, and the manner of making it—also changes depending upon the character of the section. Procedure in regard to the question of iridectomy or no iridectomy has in the main been dependent on the location of the section. The more peripheral the section, the more regularly has iridectomy been needed. In other matters which have been debated in quite recent years there has been no sweeping unanimity in opinion or practice. The question of simple division or removal of anterior capsule, except as decided by tenuity or thickness of the capsule, is a comparatively recent one. The method of subconjunctival extraction is one which has not yet been extensively practised. At present there is much interest taken in the intracapsular operation, owing to Major Smith's extraordinary work at Jullundur, in the Punjab, India.

INSTRUMENTS.

Lid Retractors.—Some form of *stop-speculum* is in almost universal use—at least, during the making of the section. It affords the widest separation of the lids with the least inconvenience. There are numerous varieties of the instrument in use, some designed to lie over the nose, others over the temple. The latter

are the better adapted for manipulation by the assistant standing in the usual position, close to the eye operated upon. Among them Clark's pattern is largely used

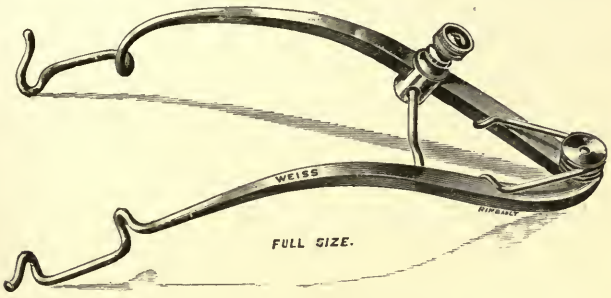

FIG. 11.—CLARK'S SPECULUM.

in England. It is simple and easily cleaned, fairly light, but strong enough to resist fairly powerful contraction of the orbicularis. And it is well curved, so that it

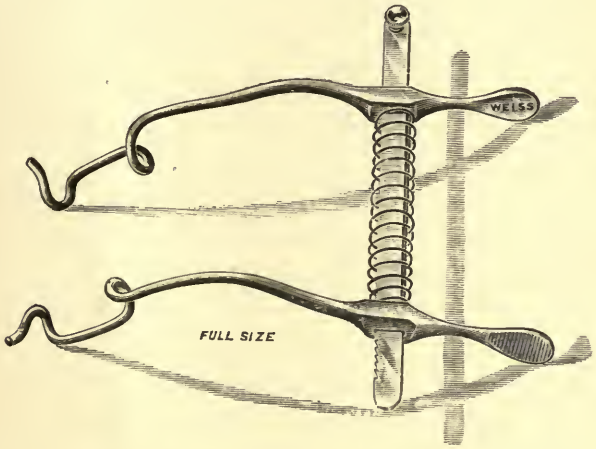

FIG. 12.—MELLINGER'S SPECULUM, MODIFIED BY NETTLESHIP.

lies ordinarily close in to the temple. The arms, however, are locked by screw adjustment. This is regarded by many as a serious defect, since it does not

allow of very rapid removal of the instrument when in use. Landolt's models—one nasal, one temporal—are fixed by a small lever and rack, worked by simple pressure of the finger. The arms of Mellinger's and Koster's ingenious instruments, working by rack mechanism, can be approximated at once for withdrawal by simple pressure between the finger and thumb of one hand; yet they effectually resist pressure exerted by the lid muscle. They are said, however, to produce too wide a separation of the lids in some cases. Other patterns provide for easy removal, but do not control the lids so well. Müller's

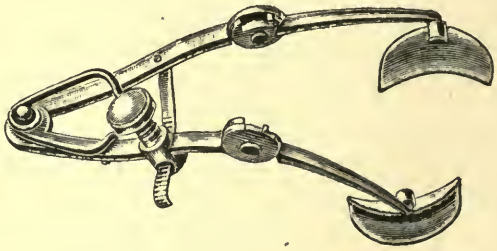

FIG. 13.—GAUPILLAT'S SPECULUM.

instrument closes and falls away automatically on powerful contraction of the orbicularis.

Some specula are fitted with solid curved end-plates to cover the lashes and lid-borders, either fixed, as in Lang's modification of Clark's speculum, or movable, as in Terson's and Gaupillat's models. In one of Lang's modifications there is a guard for overhanging upper lid. Other specula have simple bars as guards for the lashes. The benefit of such coverings is seen mainly in using a keratome for an upper section, in performing simple iridectomy or a linear extraction. It is scarcely appreciable in an ordinary flap extraction. In Landolt's instrument only two hooks pass behind the border of each lid, the bar connecting them lying in front of the lid;

that is, the usual arrangement in this respect is reversed.

In specula of any pattern the curve of the bar or end-plate, upon which the security of the hold on the lid depends, may be a little too open and shallow. The instrument is thus more easily removable. But the gain in this respect is obtained at a slight risk of the instrument slipping from between lax eyelids when it is at all forcibly elevated by the assistant. Even the leverage of the weight of the unsupported instrument may cause it to slip out from the lids of patients with narrow faces, for whom the curve of the arms is insufficient. The inner ends

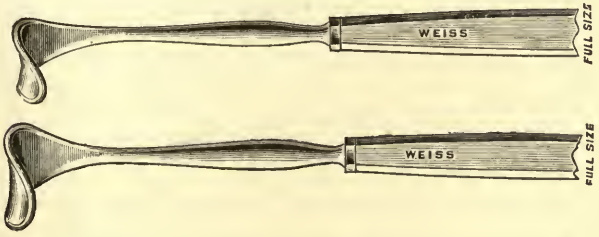

FIG. 14.—DESMARRES' RETRACTORS, SMALL AND MEDIUM SIZES.

of the arms are seen to be tilted forward, and the lower lid gradually slipping back before the instrument finally escapes. On this account a few specula—*e.g.*, Webster Fox's modification of Clark's instrument and Galezowski's and Gaupillat's—have jointed arms.

Of *single retractors*, Desmarres' is probably most used. For cataract work the small or middle size is selected, and is used for the upper lid alone, the lower lid being depressed by the assistant's finger. The pliable German silver stem should be bent as shown in Fig. 41, so that the recurved end portion of the plate is parallel with the handle. If this be not done, the lid cannot be drawn sufficiently forward without the assistant's hand being too close to the eye, inconveniencing the operator. The

separation of the lids thus secured is not so wide as with the stop-speculum, but, on the other hand, fairly efficient control is afforded over the lid muscle.

McGillivray's or Pellier's wire loops may be employed instead, or a large-sized strabismus hook, as used by Smith (Jullundur). The objection to the simple hook is that it tends to pull the outer canthus and outer part of the lid against the globe.

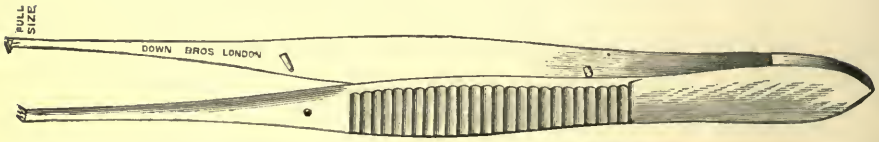

FIG. 15.—FIXATION FORCEPS.

Fixation.—Forceps used for holding the eye should have strong blades which will not bend easily, but a weak spring which will not tire the fingers quickly. The usual two teeth on one blade and three teeth upon the other commonly afford a sufficiently firm grip of the conjunctiva without tearing it. Broader ends and more numerous

FIG. 16.—LANDOLT'S FIXATION FORCEPS.

teeth would not generally give a more secure grip, because the forceps have to be applied more or less obliquely to the surface of the globe. With eyes deeply set and turned well downwards the obliquity is often extreme, so that

FIG. 17.—FIXATION HOOK, BY BADER.

the whole breadth of the ends of the ordinary forceps is not engaged. Landolt uses forceps with obliquely placed ends. In Bader's and Critchett's models each blade ends

in a single sharp claw, capable of fixing deeply in the episcleral tissue. Weiss makes a pattern with three such claws on each blade instead of teeth. The double hook shown in Fig. 17 is practically the same as the old Pamard's spear, recommended for fixation after the conjunctiva has become torn.

The Knife.—Graefe's knives in various breadths are almost the only ones used nowadays for flap extraction.

FIG. 18.—THE GRAEFE KNIFE.

The handle should be of ivory or aluminium. Steel is too heavy, and too slippery when wet.

Sir Anderson Critchett uses a knife slightly modified from the Graefe pattern. "The back of the knife is bevelled and the blade is slightly rounded; it does not permit of too rapid escape of aqueous."* Kuhnt's knife is also designed to retain aqueous. For 6 millimetres from the point it resembles an ordinary Graefe's blade, and then broadens out into the triangular Beer form. Bell Taylor's trowel-shanked knives permit of the right hand being used upon the left eye, the surgeon standing behind the patient's head, and puncturing at the nasal margin of the cornea.

Iris Forceps.—The pattern entered in the catalogues

FIG. 19.—IRIS FORCEPS.

as "curved, rectangular, with tenaculum points," is very serviceable. With less curved blades there is more danger from upward movements of the globe while the ends of

* *The Ophthalmoscope*, iv (1906), 112.

the forceps are within the wound. The ends of the forceps when closed must be smooth, in order not to catch in the iris.

A **Tyrrell's Hook** may be of service occasionally, should the iris be buttonholed.

FIG. 20.—TYRRELL'S HOOK.

Of **Iris Scissors,** de Wecker's spring scissors are perhaps the most convenient. Scissors of the ordinary

FIG. 21.—DE WECKER'S IRIS SCISSORS.

FIG. 22.—ELBOWED IRIS SCISSORS.

pattern should be 'elbowed' for use on the right eye, straight for use on the left eye.

Cystitomes, etc.—A straight instrument for opening the capsule may be difficult to use in a deeply placed eye unless the globe be turned fully downwards.

Capsule Forceps. — Couper's forceps differ from ordinary iris forceps in having a number of small teeth

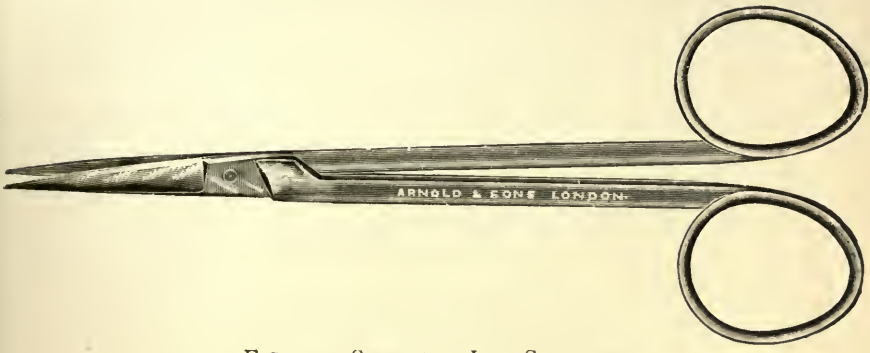

FIG. 23.—STRAIGHT IRIS SCISSORS.

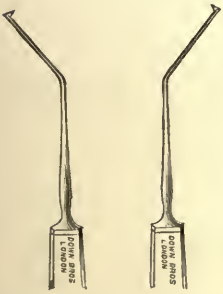

FIG. 24.—GRAEFE'S BENT CYSTITOMES, RIGHT AND LEFT.

FIG. 25.—MOORFIELDS PATTERN CYSTITOME.

FIG. 26.—WEBER'S CAPSULAR HOOK.

FIG. 27.—RECTANGULAR LENS HOOK.

FIG. 28.—TERSON'S CAPSULAR FORCEPS.

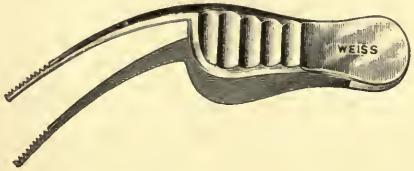

FIG. 29.—TREACHER COLLINS' CAPSULE FORCEPS.

along a portion of the lower margin of each blade near its point. De Wecker's instrument has the usual teeth at the ends, like iris forceps, and, in addition, each blade has a small tooth projecting down from its lower edge. The blades of Terson's forceps are slightly curved beyond the bend, to correspond with the posterior surface of the cornea. The blades remain separated at the bend when closed at the point, and the teeth are few in number. Thus they are not likely to grip the iris when used in simple extraction. L. Müller's forceps remain open similarly at the bend. Rochon-Duvigneaud's forceps are similar to Terson's, but each blade has numerous teeth extending from the point to the bend. Treacher Collins'

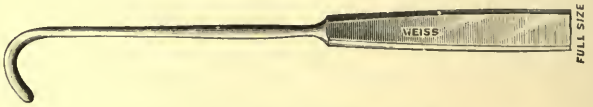

FIG. 30.—EXPRESSOR HOOK.

FIG. 31.—TORTOISESHELL SPOON.

FIG. 32.—PAGENSTECHER'S SPATULA.

pattern is like the Fischer-Arlt iris forceps, but with a number of teeth arranged for seizing the capsule.

Lens Expressors.—I have followed Mulroney and Smith, of the Indian Medical Service, in using a large tenotomy hook for expressing the lens. The hook is improved by increasing its curve nearly to a semicircle,*

* Easily done after heating the instrument in the flame of a spirit-lamp.

as shown in Fig. 41. And I have had one made by Weiss, thickened and a little flattened about the curve, to broaden the surface mostly used. The curve corresponds fairly well with the circumference of the cornea

FIG. 33.—IRIS REPOSITOR.

and of the lens, and is therefore particularly suited for the alternation of pressure and indentation, at either side and below, by simply rocking the instrument. But the same

FIG. 34.—CURETTE.

shifting of the pressure may be obtained with less curved instruments by sliding them from place to place. The point is obviously of only minor importance. The well-

FIG. 35.—SNELLEN'S VECTIS.

established tortoiseshell spoon is fairly well suited for the work, but its curve might well be increased, and the edge of the bowl is not sufficiently thick and rounded, and is

FIG. 36.—TAYLOR'S VECTIS.

not quite in the same plane as that of the stem close to the bowl. Various curettes and spatulæ are also used—straight, curved, and bent at an angle. Pagenstecher uses a curved glass spatula.

For *assisting in the delivery of the lens* by supporting it when the zonule has been ruptured, Bowman's or Critchett's or Pagenstecher's spoon may be needed. The two former are flat from side to side, being curved only in the one direction. They are well suited for holding back the vitreous, and Bowman's, with fine grooving only at its extremity, is better suited for passing down between lens and vitreous than Critchett's, with thickened rim.

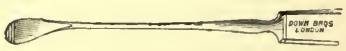

FIG. 37.—BOWMAN'S SPOON.

Pagenstecher's bowl is unnecessarily large for supporting the lens, but is possibly better for actually extracting the lens. For this purpose, however, Snellen's or Taylor's wire loop is well adapted. One of these instruments should always be at hand, to be rapidly sterilized in the flame in case of necessity.

Iris Repositors. — A flat *spatula*, such as shown in Fig. 33, is in common use. I have used a *curette* in order

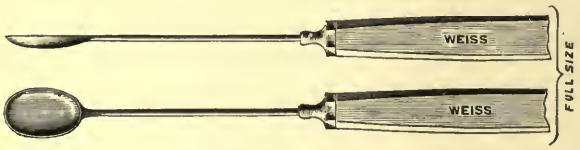

FIG. 38.—PAGENSTECHER'S SPOON.

not to add to the number of instruments in use. It is of the pattern shown in Fig. 34. The groove in its concave surface should be shallow and its edges thick and rounded, and the curette itself not broad. Being made of German silver, the instrument is sufficiently pliable to be easily bent by the fingers. It may be used, not only for replacing iris, but also in simple extraction for applying counter-pressure above the wound. For this purpose,

used upon the right eye and held in the left hand, the instrument must be considerably curved. We also employed the curette for removing mucus from the palpebral conjunctival surface at the close of the operation, and very occasionally at the beginning of the operation to detach mucus lying in the recesses about the plica.

Irrigators for douching the anterior chamber. The ordinary laboratory 'wash-bottle' arrangement of flask and glass tubing served us in Bombay for over ten years,

FIG. 39.—1. IRRIGATOR FLASK. 2. NOZZLE. 3. MOUTH SCREEN.

fitted with an extension of rubber tubing, 1½ to 2 feet long, and a readily removable silver nozzle. This was the locally obtainable substitute for McKeown's more elaborate apparatus.

At first we used to blow into the flask through a plug of sterilized wool to start the syphon action. Afterwards we used a ball syringe (not shown in the figure) to start the flow. Each flask of fluid frequently served for half a dozen operations, and the syphon action once started was usually kept going without stoppage throughout, the fluid being retained in the outflow

tube between the successive operations. Thus the rubber ball was only attached for the moment when it was needed. The tubing, glass and rubber, was kept in strong perchloride lotion always when not in use, and the same fluid was passed into the tubes by syphon action, and retained there by a clamp some hours before operating.* The small nozzle was made of silver, sufficiently pure that it did not blacken when heated in the flame of a spirit-lamp. The array of cannulæ supplied with McKeown's apparatus was not found necessary.

Lippincott† passes the rubber tubing close to the nozzle through a holder provided with a 'shut-off,' to prevent backward flow when the reservoir is allowed to drop below the tip of the tube.

A simpler apparatus, which has been used by Wickerkiewicz, Uhle, and others, is the 'undine,' a retort-like flask with long bent outflow tube, bearing a nozzle. The pressure of the outgoing stream is changed by altering the inclination of the flask.

Simple pipettes with rubber nipples—ordinary medicine droppers—have also been employed, sometimes fitted with nozzles. On the same principle, large rubber bulbs have been used by Kuhnt and Wanless (Miraj, India). It is stated that these rubber syringes may throw bubbles of air into the eye, and the force of the current produced by compression of the bulb cannot be so accurately measured as when the propelling force is simply gravity. An advantage claimed for the rubber ball is that it can be used with one hand, enabling one to dispense with an attendant. Wanless's bulbs are fitted with McKeown's cannulæ by bayonet-joint attachments.

Piston syringes are somewhat liable to be out of order

* It is obvious that the irrigating fluid which first passed through these tubes from the flask must have contained a trace of perchloride, and was therefore fit for use only on the surface of the globe.

† *Amer. Journ. of Ophth.*, xxi (1904), 193.

when needed, and with them the force of the current is more difficult to regulate than with ball syringes. But the double-current instrument introduced by Chibret* in 1895 stands in a class by itself. Its essential principle is that, by its double cannula, fluid is sucked out of the eye in quantity equal with that introduced. Thus the tension within the chambers remains unaffected unless the outflow tube should become blocked. Chibret's syringe is made by Aubry. Lagrange and Aubaret† use a very similar instrument made by Creuzen and Soulard, 47, Cours de l'Intendance, Bordeaux.

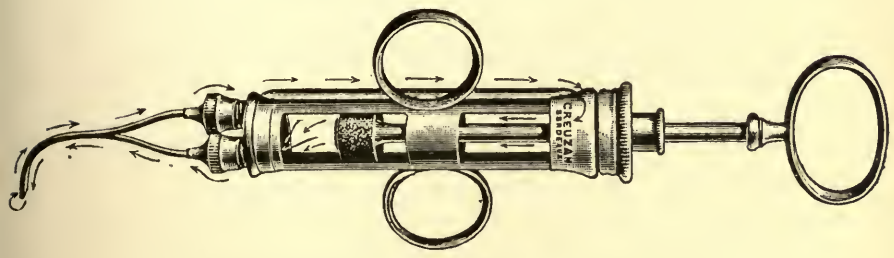

FIG. 40.—DOUBLE CURRENT SYRINGE, BY LAGRANGE AND AUBARET.

Intra-ocular irrigation is intended primarily for washing away cortical remains, but is useful also for removing blood, iris pigment, or a piece of iris isolated by the knife, also air bubbles. The stream of fluid can be employed also for douching the conjunctival sac before operation, and for keeping the cornea moist during operation. It has been used also for filling the anterior chamber in eyes with collapsed cornea, whether after loss of vitreous or not. The fluid in general use is physiological salt solution, 0·7 per cent. Lagrange and Aubaret, desiring a closer approximation to the composition of aqueous

* *Ann. d'Ocul.*, cxlii (1895), 120.
† *Arch. d'Opht.*, février, 1905.

humour, use the following: Water 1,000, sodium chloride 6·890, calcium chloride 0·113, potassium sulphate 0·221. The solution must be sterilized, and should be used at a temperature a few degrees above blood-heat in the flask, to allow of a little cooling as it passes through the tube.

Chibret used 1 part of cyanide of mercury in 20,000 boric acid solution. He injected 20 to 30 grammes of fluid—*i.e.*, three or four times the contents of his syringe.

GENERAL ARRANGEMENTS.

For the general arrangements—fittings, furniture, lighting, etc.—of the operating room, works on eye operations in general must be consulted. The conditions under which most successful work is done in India would astonish surgeons accustomed only to the elaborate provisions for asepsis in well fitted hospitals. But in India much of the work is done practically in the open. The windows are kept constantly open, so far as the strength of the prevailing wind allows, and this renders of no account dirty surroundings, furniture, patients, and assistants. The operating room in Bombay was the out-patient room just cleared of the morning crowd of out-patients.

In our private work at patients' houses sometimes everything in the room was more or less filthy, and the floor perhaps cow-dunged, so that care had to be taken to avoid raising any dust in the room. The light was sometimes poor, from small, low windows, opening on to a verandah, or partly covered by weather-boards. The light from a small window near at hand is ample, if other sources of light are shut off to avoid multiple corneal reflexes, and if the window be sufficiently high; and it should face away from the sun, lest there be any dazzling reflexion from below.

Unless the operation can be performed upon the patient's bed, some provision must be made for placing the patient in bed afterwards without any effort from him. An ordinary domestic table, with a few coverings and a single pillow, generally places the patient's head at a convenient level, so

that the surgeon, standing upright, or nearly so, may work with forearms flexed at rather less than a right angle. The coverings should be sufficiently strong to support the patient's weight when he is being carried to bed. A small table must be placed near the patient's head during operation, for the instrument tray and for a bowl of lotion.

THE PREPARATION OF THE PATIENT.

On admission the ordinary hospital rules as to cleanliness are observed, paying especial attention to the washing of the eyelids and neighbouring parts. A laxative is administered, and the patient's control over his eye and lid movements tested, and developed so far as practicable.

In testing the patient's self-control, he is required to keep his eyes turned steadily downwards while the lids are lightly manipulated, and while eversion of the upper lid is carried out. Most of them at first roll their eyes up and close their lids forcibly, but after a little practice have no difficulty in curbing these impulses. After this they can almost always be depended upon to exercise the necessary restraint during operation. Some nervous, timid people require training for a day or two to become accustomed to the demand upon their will-power, and then behave extremely well.

Patients are required also to maintain fixation of their eyes in different directions, following movements of their hands. In this test the eye upon which operation is not contemplated, if it be a seeing eye, is screened but not closed. The patient must be able to look towards his hand without seeing it, the direction of his eyes being governed by muscular sense. Otherwise, during operation the eyes are apt to roll upwards as soon as the vision of the good eye is cut off by the surgeon's hand holding the fixation forceps.

In this test we may encounter an extraordinary stupidity. Some of our elderly patients, generally cultivators who had been blind from cataract in both eyes for perhaps a few years, had so lost the habit of fixation that they could not be induced to rotate their eyes as directed. Others, through lack of will-power, could maintain fixation of the eyes for a few seconds only in any position but that of rest. Even after some days' training by the hospital assistants, some very stupid people failed to look downwards, except by turning their heads down. Formerly much time was wasted upon them, and in a few cases the extraction was performed under chloroform. Latterly they were operated upon by Czermak's lower section. Nearly all of them could turn their eyes a little upwards. Fortunately, this stupidity is rarely combined with nervousness; these patients neither roll their eyes about during operation nor squeeze their lids together.

A '*Test Dressing*' should be applied the night before operation to untreated cases, but not to those which have been treated for conjunctivitis. It need consist of nothing more than a strip of lint or gauze fixed over the lids by a single turn of bandage. Its object is to retain on the lint and on the lid margins, and at the inner canthus, any discharge which may form within the conjunctival sac during the night. It serves simply as a guarantee that all discharge shall be visible at the surgeon's morning inspection. The bandage should not be removed before the time of the inspection, or, if removed earlier, care must be taken that the lids are left untouched, and that the bit of lint is available for examination.

An *Early Morning Inspection* of the patient is strongly advisable, in order that a final assurance may be given as to the fitness of the eyes for operation. Provided that satisfactory perchloride irrigation is to precede operation, cases with chronic conjunctival changes may be accepted showing scanty, thin, dried discharge on the lid borders, or an abnormally large accumulation of mucus at the inner canthus.

But an additional thread or flake of mucus lying in the lower fornix suggests the need for caution. As a rule, the operation must be postponed for a few days' treatment, or at least the decision as to operation must be deferred for a few hours. If at a second inspection after this interval—*i.e.*, about the usual hour for operating—any fresh mucus is found in the fornix, operation should be postponed. At this second examination, also, one may judge to what extent conjunctival congestion seen on removal of the bandage was due simply to occlusion of the eye. Such congestion will have disappeared in an hour or two, and any injection still remaining may be attributed to the presence of pathogenic organisms.

Much less importance attaches to scanty discharge from a conjunctiva roughened and thickened by very chronic inflammation, than from a membrane nearly normal in appearance. For in the former instance, not only may the altered mucous membrane be expected to withstand very vigorous perchloride douching, but we have learnt from practical experience not to fear the result of operation performed on such an eye after the suitable douching. It seems reasonable to admit that such conjunctivæ may furnish a little abnormal secretion quite independently of the action of any existing micro-organisms. And it is a matter of fairly general observation that in very chronic conjunctivitis the only pathogenic organisms likely to be found are staphylococci of feeble virulence or Morax-Axenfeld diplobacilli. And there appears to be little difficulty in getting rid of diplo-bacilli—temporarily at least (see Chapter IV, Asepsis). We are much more afraid of quite *recent* conjunctival changes—slight injection, with a mere trace of thickening and roughness and of discharge. We fear these, knowing from bacteriological examination that the conjunctivæ of some of

the eyes upon which we operated contained numerous pneumococci or streptococci.

Occasionally, in up-country patients, we decided to operate in the presence of chronic inflammation with distinctly freer discharge than above mentioned. In these cases preliminary perchloride irrigation was practised at the time of inspection, lasting perhaps for ten seconds. The lotion, 1 in 3,000, was squeezed out of pads of lint, and the cases were noted for the maximum treatment just before operation.

In our private practice infective iritis and irido-cyclitis have been rather more frequent than in hospital work, and we have thought that the higher incidence was possibly accounted for by the non-use of the test dressing and morning inspection.

To show fitness for operation without antiseptic lotion, the test bandage must reveal no trace of abnormal secretion.

At the morning examination, also, the opportunity may be taken of testing the patient's control of his eye and lid movements. Operation may have to be postponed for further training of the patient. The administration of a nerve sedative may be found advisable to dull an excitable patient's fears; or operation by lower section, preferably subconjunctival, may be decided upon in the case of a very unintelligent individual.

Orders can also be given now as to the perchloride treatment of the conjunctiva immediately before operation, the instillation of adrenalin, etc.

For nervous patients a bromide draught at night may be possibly advisable. A good night's rest, plus some of the influence of the drug still remaining, must help to make the patient collected and calm for the ordeal. At times we have used bromide and chloral fairly extensively, 10 or 15 grains of

each, but given an hour or two before operation. The effect was often very noticeable. Morphia and other sedatives have been used also, with the object of lessening the risk of prolapse of iris after simple extraction.

General anæsthesia by hypodermic injection of scopolamine and morphine has been recommended in nervous and restless patients (Chapter IV).

PRELIMINARIES.

The point and edge of the knife are tested upon a leather drum. The selected instruments must be cleaned and sterilized, and laid in order on a rack. The hands of the surgeon, of the assistant, and of the attendant are washed thoroughly and steeped in perchloride lotion. The assistant bathes the skin of the lids and surrounding parts, and (following a practice now given up by many) douches the conjunctival sac with perchloride lotion, and follows this by the instillation of cocain solution. In many cases the use of adrenalin chloride solution, before or with the cocain, is of benefit. The surgeon and the assistant don mouth masks.

The instruments commonly required are shown in Fig. 41, plus the Desmarres' retractor, which is only quite exceptionally needed. In addition, a Bowman's spoon or a wire loop should be at hand, and perhaps also a Tyrrell's hook. Some surgeons would replace the cystitome by capsule forceps. A sharp hook might rarely be wanted also.

The **Sterilization of Instruments** in eye work is commonly by boiling in water, or, better, in 1 per cent. soda solution. The only difficulty is with the knife, which loses its edge by repeated boiling. Where a number of operations have to be performed in succession, more than one set of instruments is ordinarily required. For example, Elliot's arrangement in Madras is this: He has a rectangular sterilizer 22 inches long, 6·5 inches broad, and 5·5 inches deep. This holds four perforated aluminium instrument trays, each of them 5·5 inches long, 5 inches broad, and 1·5 inches deep. Each has handles at the

two ends, by which it is lifted out of the boiling water with the aid of metal hooks. This allows for one tray to be on the table containing the instruments in use, one to be cooling (in a cloth wrung out of 1 in 3,000 biniodide solution), and two to be boiling. This gives each set of instruments ten minutes' boiling. Neither knife nor scissors are sterilized upon these trays; their points are immersed by an assistant for two minutes in the boiling water of the sterilizer.

Many surgeons—*e.g.*, de Wecker, Lagrange, de Lapersonne, Truc—prefer dry heat (130° to 150° C. in a stove for an hour).

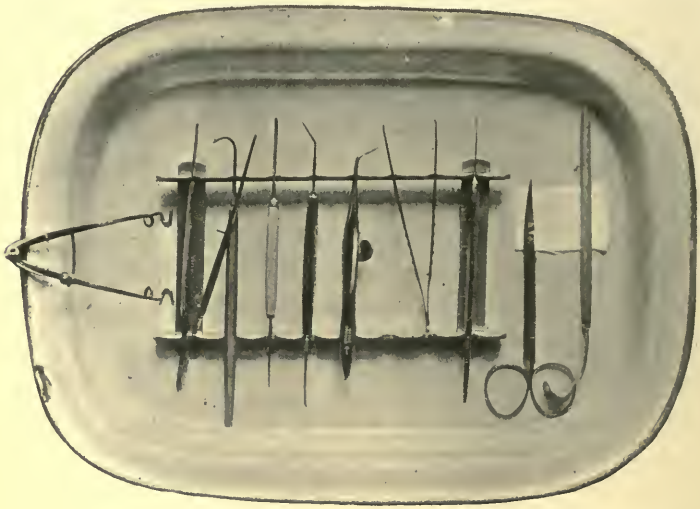

FIG. 41.—INSTRUMENTS LAID OUT FOR CATARACT EXTRACTION.

Stop-speculum; fixation forceps; strabismus hook (expressor); curette, used also as repositor; Graefe's cystitome, point downwards; de Wecker's scissors; iris forceps; knife; curved scissors for eyelashes; Desmarres' retractor.

Louis Dor and Rollet (Lyons) sterilize in boiling oil at 140° C. The oil is freed from oleic acid by maceration for twenty-four hours in absolute alcohol.

At the C. J. Hospital, Bombay, we depended on the flame of a spirit-lamp for sterilizing the points of cystitome and of conjunctival and iris forceps, the curette and expressor hook, and the nozzle of the irrigator. Simple washing with sterilized

lint, soap, and carbolic lotion, 1 in 60, was made to suffice for the knife, scissors, speculum, and retractor.

This practice was begun at a time when the work was less heavy than it afterwards became, when the assistants were untrained, and when we had only a small supply of instruments, and no sterilizer. The one set of instruments was used for the whole morning's work, and I had to be personally responsible for all details of any importance. The method proving reliable and on the whole satisfactory, it was continued. But the few minutes of time wasted between one operation and the next could not be well spared, and on this account other arrangements were being made. The details may, however, be of use to others in circumstances such as ours.

Details of Sterilization in the Flame.—To minimize the slow destruction of the iris forceps, and especially of the cystitome, by the repeated heating, the points of these instruments were allowed to remain in the flame for a period just short of that necessary to make them red hot. A trace of black oxidized metal had to be scraped off them occasionally. Since, as it happened, our tenotomy hooks and curettes had bone handles, these instruments had to be rapidly cooled after heating by being plunged into a bowl of carbolic solution. The irrigator nozzle held in the fixation forceps needed to be heated to a dull red before the first operation of the day, in order to burn away matter in its lumen. It was also cooled by immersion in the fluid to save time. Afterwards, between one operation and the next, the nozzle was not removed from the rubber tube. Only its tip was placed in the flame, the fluid being drawn back from it by a slight sliding movement of the finger and thumb which held the rubber tubing. It was only heated enough to give a hissing sound, when a little fluid was allowed to spurt through it to cool it again.

Some of the nozzles used were rather short for this heating of their tips, while still attached to rubber tubing. The interior of the tubing immediately beyond the metal got roughened after a time, and unless it were cut away, small particles of rubber were apt to be thrown into the eye by the stream of fluid passing through. A few such particles were left in eyes, fixed by blood-clot, but they gave rise to no irritation, and were slowly absorbed.

In depending upon simple washing of the knives and iris scissors, it was realized that some responsibility was incurred. The first washing of the day was in particular very thorough, so much so that the knife edges probably suffered quite as much as if they had been plunged into boiling water in the usual fashion.

We used our instruments dry, simply laid out upon a rack as they were got ready. It is more usual to immerse them in sterile, unirritating fluid before and during the operation. Such fluid must, of course, be changed after every operation.

Antiseptic lotions must be always made the day before use, or earlier. Drops for instillation should be freshly prepared, and boiled for three to five minutes in Ströschein's or other suitable bottles. Boiling once for five minutes has been found not to impair the action of the ordinary cocain solution.

During operation the curette in particular frequently needs cleansing again more than once. It is washed with bits of lint taken from the bowl of perchloride lotion standing near the patient's head. It is then, after rinsing in a stream of saline fluid from the irrigator, fit for entry within the wound. Similar treatment suffices also for the nozzle of the irrigator, should its sterility have been rendered doubtful by contact with the conjunctival surface. This friction with wet sterile lint may be depended upon to remove any moist (and therefore loosely adherent) material with which these instruments might have become soiled during the progress of the operation. Should any toothed instrument need sterilizing quickly in an emergency, it may be passed through the flame of a spirit-lamp.

Lippincott* advises continuous sterilization of knives in a 20 per cent. solution of formol, containing 3 per cent. of borax. The knives are placed in perforated steel boxes in the solution, and before use are rinsed in sterilized borax solution and wiped with sterile cotton. Each knife can thus be used only once in a day. Lippincott found alcohol ineffectual for sterilizing purposes. Asmus recommends similar continuous sterilization in the *spiritus saponatus* of the Prussian Pharmacopœia. [For its composition, see *The Ophthalmoscope*, (1904) ii, 294].

* *Arch. of Ophth.*, July, 1898.

Perchloride Irrigation.—In attempting to clear away micro-organisms from the operative field, we have douched with 1 in 3,000 perchloride lotion. Since the reaction of the conjunctiva varies greatly according to the condition of the latter, systematic efforts were made to keep the effect nearly uniform by varying the period of irrigation. Practically normal conjunctivæ were treated for 1 to 1¼ minute; others for periods up to 1¾ minute. The time was regulated by our estimate of the amount of douching which the particular mucous membrane would withstand without excessive reaction. The shorter application, one minute, was not found to be too severe for the most delicate conjunctiva, whereas the longer treatment was still quite insufficient for some scarred or roughened and thickened mucous membranes. For these a short supplementary douching was added after the cocain instillation.

This one particular concentration of the lotion was in almost regular use at the Bombay Hospital for ten years or more. But it is not recommended as certainly the most suitable strength. We tried stronger solutions, 1 in 2,000 and 1 in 2,500, correspondingly reducing the quantity used; but we did not obtain quite the same result. There was more inflammatory swelling of the lids and conjunctiva, and this deep reaction was precisely what we wished to avoid. On the other hand, weaker solutions used more freely should give more of the superficial action which is desired. For instance, the ordinary 1 in 5,000 solution, employed for nearly double the period which we found necessary with the 1 in 3,000, might have been more satisfactory. But we were deterred from experimenting by old experience of suppurations encountered under the use of this weaker lotion, doubtless used in insufficient quantity. Finding that with the 1 in

3,000 we were able to abolish suppurations, and at the same time almost always to avoid excessive reaction, fears for our statistics made us rest content.

The patient is placed recumbent beneath a jar of the lotion furnished with rubber tube and glass nozzle. An assistant everts the upper lid and depresses the lower, and keeps them both constantly moving in the vertical direction, while an attendant directs a stream of fluid on to the exposed surfaces. The movement of the lids is to ensure penetration of the antiseptic to the furrows and recesses, more particularly of the upper fornix.

In the cases where it is intended to instil adrenalin the period of irrigation should be very slightly prolonged, because the immediate reaction to the perchloride is lessened by the adrenalin. The reaction is delayed simply.

Rather more lotion is used also in cases where there has been lacrymal obstruction, whether it has been treated or not by excision of the sac.*

The irrigation usually causes some smarting, but this gives way rapidly to the cocain instillation.

Anæsthesia. — Cocain is instilled several times at definite intervals. It is used in solution varying from 2 per cent. to 5 per cent. (I have instilled always a 4 per cent. solution four times.) If this be done at three minutes' intervals, the eye is ready for operation one minute after the final instillation—*i.e.*, ten minutes after the first instillation.

On each occasion several drops are used, for though little remains in the conjunctival sac, the trace of fluid already there has to be displaced, and if the conjunctiva be thus flushed out,

* Plaut and Zelewsky (*Klin. M. f. A.*, 1901, S. 369) have shown that after extirpation of the lacrymal sac bacteria are more numerous in the conjunctival sac.

the cocain solution penetrates to the fornices undiluted with tears. The assistant should watch the patient in the intervals to see that the eyelids are kept closed, to prevent drying of the corneal surface and subsequent exfoliation of epithelium. Landolt uses this solution five times during twenty-five minutes. Haab,* in the case of patients with little self-control, and in cases in which prolapse of vitreous is to be feared, instils a drop of 3 to 5 per cent. solution every three minutes for half an hour. It is said that, in spite of all precautions, such frequent instillations tend to cause opacity of the corneal epithelium, and encourage subsequent collapse of the cornea. Haab uses the drops in both eyes, 'to guard against the disturbing accident of reflex closure of the lid, in case a drop of fluid of any kind accidentally gets into the other eye during the operation.' With both eyes thus being rendered anæsthetic, watchfulness is more essential, to prevent opening of the lids in the intervals of instillation.

The degree of anæsthesia ordinarily attained by cocain varies. The quantity used by us sometimes sufficed to abolish pain; but in other cases the pull upon the iris for the iridectomy was painful, and some patients winced a little even from the grip of the fixation forceps. Possibly the earlier drops may have been often washed away by a flow of tears, excited by the perchloride irrigation. Koller (New York) injects cocain subconjunctivally for cataract extraction, to make the operation quite painless.

None of the other local anæsthetics which have been tested in eye work—eucain, holocain, stovain, alypin, etc.—appear likely to displace cocain. The blanching effect of cocain is useful in operations with a conjunctival flap, especially in our work, owing to the hyperæmia excited by the perchloride douching. Maynard (Calcutta), operating with a small conjunctival flap, and using alypin, found it advisable to add adrenalin solution to control bleeding.

Of late years many ophthalmic surgeons have utilized preparations of *adrenal extract* more or less regularly to enhance the effect of the local anæsthetic and to lessen bleeding. I have used the well known adrenalin chloride

* 'Operative Ophthalmology,' p. 128.

solution, and also ophthalmic discs of 'hemisine.' The solution, 1 in 1,000, unsterilized,* was not mixed with the cocain drops, nor instilled alternately with them, but was used only before the cocain period. It was dropped into the eye immediately after the perchloride irrigation, and the cocain instillation deferred for five minutes. In cases where much perchloride had been used, and where, in consequence, an unusual degree of hyperæmia had to be combated, a second instillation was made two and a half minutes after the first. This aid is quite necessary in the subconjunctival extraction of Czermak, and almost so in operations with a large conjunctival flap, to control hæmorrhage. It is of great value also in nervous, excitable patients. The docility and quietude of these patients during operation, thus rendered certainly painless, are in striking contrast with their uncertainty and unreasonableness under cocain alone. It is thus calculated to reduce the number of vitreous losses from spasmodic closure of the lids, and is indicated where vitreous loss is especially to be feared, as in high myopia. The more complete anæsthesia may be useful also in operating upon children by linear extraction. And for eyes still congested from a glaucomatous attack (Chapter VI), and especially in excising prolapsed iris, the help of adrenalin is needed, since, as is well known, cocain alone acts imperfectly in these conditions. In some of these latter cases a third instillation of adrenalin solution was made, and the intervals between the cocain instillations prolonged, so that a total period of possibly half an hour was thus occupied. Even thus the pull upon previously congested iris may be painful.

* To avoid frequent opening of the original bottle of solution, about enough for the day's supply was decanted into a small sterilized bottle for immediate use.

In simple extraction there are especial advantages derivable from the combination of adrenalin with cocain, which tend to reduce greatly the liability to prolapse of iris (see Chapter IV).

With this combination a faint corneal milkiness is occasionally noticeable at the time of operation, followed next day by a rough surface from exfoliation of epithelium. This, in spite of watchfulness during the instillation and frequent moistening of the cornea during operation. When used freely upon previously congested eyes, whether for cataract extraction or excision of prolapse, there is a possibility of a more unpleasant after-effect. In a case of acute glaucoma of both eyes, in which we instilled adrenalin solution three times, alternating with the cocain drops before performing iridectomy, we found next day both pupils and irises covered with a layer of lymph. This took some days to become absorbed, and left some fine posterior synechiæ. We attributed it to the reaction following the adrenalin-constriction of blood-vessels already weakened by the acute glaucoma.

The *mouth-screen* or *respirator* shown in Fig. 39 is simply a layer of flannel stretched over a wire frame, and fitted with elastic loops to hang over the ears. It is sterilized by prolonged soaking in sublimate solution. Gauze veils have been largely used, covering mouth and beard, and in some cases the nose also.

INITIAL STEPS.

The ten-minutes cocain period being ended, the patient must be lying on a suitable table or bed. The pillow is protected by a waterproof sheet covered with a towel, and another towel (preferably sterilized) covers the patient's head and forehead, to protect the surgeon's clothing and to serve as a clean support for his hands.

In addition to the instrument tray, there must be at hand a bowl of 1 in 3,000 perchloride lotion, containing bits of sterilized lint or absorbent wool, also of gauze or muslin.

The surgeon takes up his position at the head of the patient, the assistant at the same side as the eye to be operated upon, and an attendant with the irrigator opposite to him.

Expression of Meibomian Secretion. — The lid borders are squeezed together, with their conjunctival surfaces in contact, between the surgeon's left forefinger placed horizontally on the upper lid and his right thumb-nail on the lower lid (Fig. 42). Portions of the lids are

FIG. 42.—EXPRESSION OF MEIBOMIAN SECRETION.

thus treated successively and repeatedly until no more fatty matter can be expressed from the mouths of the Meibomian glands. As it appears on the lid margins, the secretion is wiped away by the assistant with bits of lint from the bowl of sublimate lotion. At the same time the opportunity may be taken to swab the edges of the lids, as a final cleansing.

Unless the glands are well emptied, one may find that during the operation the irrigating fluid used for moistening the eye and for washing out the chamber is very apt

to cover the globe with a floating iridescent scum, or with a succession of small fatty particles, which cannot be completely washed away unless the speculum be removed and the squeezing of the lids be repeated. The fatty matter is seen to ooze from the mouths of the glands close to the arms of the speculum, where the latter cross the lid borders.

The quantity of matter which can be expressed from some of the glands is remarkable, especially in the flaccid lids of some old people; and it varies much in consistence and colour, occasionally looking like pus. There can be little doubt that, in some cases at least, it is highly desirable to prevent this material from entering the conjunctival sac during, or even after, operation. I smeared secretion from ten unselected lids upon Löffler's serum, but only obtained cultures in three instances—once white staphylococci alone, once xerosis bacilli alone, and once the two organisms together.

Often so much pressure is required that it becomes a little painful. But patients are not allowed to demonstrate by groaning or drawing in their breath or moving their heads. Otherwise there is great risk of their presuming upon the licence allowed them, giving trouble later by attempting to close their lids, with dire consequences. This Meibomian expression, and also the lid manipulations now to be described, are useful as a test of the behaviour to be expected of the patient during the operation. A warning of the need for special care is frequently thus obtained.

If perchloride has been used as directed, the lids are now everted and moved freely upon each other laterally, while a stream of physiological salt solution is directed upon them from the flask by the attendant. We expect to find in fairly normal conjunctivæ, in response to the

irritative and coagulative action of the sublimate used for douching, an accumulation of mucus in the fornices, with perhaps a trace of shreddy membrane lying over the tarsi. This is washed away, any adherent threads being detached with a bit of gauze from the bowl of lotion standing near. The curette may be used to remove particles of mucus lying in the hollows about the plica. Already, also, we may generally detect some slight swelling of the lids—perhaps only a barely perceptible fullness as compared with the lids of the fellow eye. In spite of this sign of reaction, it is well to use a little more sublimate now from the bowl of lotion, squeezed out of a pledget of lint at least once. The lids are then released, and the remains of the lotion washed away with normal saline after the insertion of the speculum.

When too much of the antiseptic has already been applied, there may be loose pseudo-membranous exudation covering the greater part of the upper tarsus. The bulbar conjunctiva towards the fornices may be a little swollen, and the swelling of the lids will be more noticeable, with slight injection of the lid borders. Though by the end of the operation these signs will have become slightly more marked, but little further increase need be anticipated later.*

It is much more common to find the reaction insufficient; there may be scarcely any mucus secreted at all. Rather more lotion must then be used, squeezed out of the pledget of lint perhaps three or four times. In conjunctivæ diffusely scarred or thickened, roughened, and indurated, the formation of mucus is always very scanty or entirely wanting. Here the supplementary perchloride

* Throughout our experience the conjunctival lesions known to have been produced by the perchloride—patchy pseudo-membranous conjunctivitis from destruction of epithelium—could be counted on the fingers of one hand.

treatment is even a little more free, being continued in the case of the chronically thickened palpebral membranes till a faint superficial paleness is seen, evidently due to change in the superficial epithelium. In the diffusely scarred conjunctivæ this sign is not commonly obtained. (It will be remembered that a few of the worst conjunctivæ we had to deal with in Bombay had already had two applications of the perchloride, the first being at the early morning inspection. They were thus treated three times in all. They never reacted excessively, and, on the other hand, we had reason to believe the treatment efficacious, for we never had any infective after-troubles in these cases.) In any case, this supplementary douching is much shorter than that carried out before the cocain instillation.

Should perchloride irrigation not have been practised, the surgeon having decided in favour of simple mechanical cleansing, this is now carried out. This is preferably by irrigation with warm sterilized normal saline solution, combined with careful swabbing, more particularly of the palpebral conjunctiva and of the fornices, and of the recesses about the plica. For the retrotarsal folds a number of small swabs are required, mounted on glass rods or held in forceps. Some surgeons use simply boiled water, others boric acid lotion, or some weak antiseptic solution, such as mercuric cyanide, 1 in 5,000, or weaker.

The irrigator attendant is required for the one instrument throughout the operation. It is his duty, apart from the execution of particular orders, to prevent drying of the cornea. He should drop a little fluid upon the eye in most of the intervals between the steps of the operation; he should not use an unnecessarily large quantity, flooding the conjunctival sac. He must avoid allowing the sterilized nozzle of the tube to touch the surgeon's fingers at any time. The nozzle there-

fore must, as a rule, be kept at a distance of 2 or 3 inches from the eye. He must be careful also to avoid accidentally spraying the patient's face with the solution. In one of our cases a considerable loss of vitreous was caused by reflex closure of the lids excited in this way.

The speculum is then inserted between the lids.

In applying the speculum it is held with its arms pressed together in the right hand for the right eye, and in the left hand for the left eye. The upper lid is drawn forward by seizing the eyelashes between the thumb and forefinger of the other hand, and the upper bar (or plate) of the speculum slipped beneath it. This lid being then released, the lower lid is drawn down, and the other arm placed in position. The spring of the instrument is commonly sufficient to separate the lids to their utmost. Very occasionally the arms may need to be pressed further apart by the fingers, or, in very prominent eyes, a too wide separation may be reduced by finger pressure before the instrument is locked.

If at any time after the making of the incision the instrument has been removed, in its re-insertion the upper arm is again placed in position first; but during its insertion the lower lid is drawn away from the eye by the finger of the assistant, lest by contracting on the globe it should force the wound open.

In thin patients the weight of the speculum is apt to draw the lower lid back so much that the end of the arm of the speculum (Clark's model), lying in front of the lid border, catches behind the orbital margin. In any case where the arm (or end-plate) of the speculum is seen pressing upon the eye it should be elevated, both to take the weight of the instrument off the globe and to make room for the fixation forceps. This is done by a forward push at the temporal end of the instrument with the little finger or side of the hand, after taking up the knife in readiness to make the section.

Except in extraction by downward section, it is convenient to retain the speculum as long as possible—*i.e.*, till the final cleansing (curetting) of the conjunctiva. But since it gives no control over the action of the peripheral fibres of the orbicularis muscle, and since its presence increases the tendency to expulsion of the contents of the globe on contraction of the

muscle, its withdrawal may be found necessary at any stage after the completion of the incision. Some surgeons always remove it then, others at various later periods—after any one of the steps of the operation.

The outer lashes of the upper lid are cut short by curved scissors, beyond the point where the arm of the speculum crosses the lid border. This is only omitted if the eyes be so prominent that the lashes lie out of the line of the knife when in position for the corneal section. It is obviously important that no portion of an instrument shall touch the lashes before entering the wound, but in this connexion removal of any but the outer lashes of the upper lid is uncalled for.

The eye is then at once moistened with a stream of fluid from the irrigator, otherwise it is extraordinary how soon the corneal surface becomes dry. The excess of fluid is run out of the conjunctival sac by momentarily tilting the head to the side; or, if necessary, it may be mopped up at the outer canthus by the assistant with a pencil of moist gauze or lint taken from the bowl of lotion.

The patient must look downwards to expose fully the upper corneal circumference in the palpebral aperture. Very prominent eyes scarcely need be turned down at all. Sunken eyes need to be rolled down well; the patient should look towards one of his hands held up by the assistant. Sufficient rotation of the globe may be impossible owing to cicatricial contraction of the conjunctiva, the retracted fornices being fixed by the speculum. In such cases Czermak's lower subconjunctival section (Chapter IV) should replace the ordinary one.

It is well that instructions to the patient regarding the position of his eyes should be given by the assistant, who stands near the position towards which the eyes have to be turned. Nervous patients, especially those blind in both eyes,

feel a natural inclination to look towards the person who issues the commands. They are often able to respond better to the assistant who has trained them than to anyone else. No bystanders are to be permitted to add instructions or remarks, and the patient must not be allowed to answer by word of mouth to orders given, otherwise he is apt to substitute this in some degree for compliance with the directions given. The orders given should be as few as possible. And it is important to avoid making the patient look downwards earlier than necessary, lest the patient's stock of self-command should become exhausted, and early relaxation of effort should lead to an upward roll of the eyes.

THE COMBINED OPERATION.

The above preliminary measures apply to all the modifications of the operation for cataract extraction by upper section. A full description will now be given of each step of the 'combined' flap extraction—*i.e.*, with iridectomy. This may be regarded as the standard method of extraction, since in many cases it is the only operation at all suitable, and is performed almost exclusively by many surgeons, and is especially the operation for beginners. After the incision has been made, a piece of iris is removed and the lens capsule opened. The lens is then expelled by pressure, its capsule being left behind. Later, in Chapter IV, each step of the operation will be more fully discussed and alternative procedures described, more particularly 'simple' extraction, without iridectomy, and intracapsular extraction. Finally, in Chapter VI the 'linear' extraction of soft cataracts will be described, together with measures adapted for some complicated cataracts.

THE SECTION, as commonly made in the 'combined' operation, raises a flap comprising the upper two-fifths, or rather less, of the cornea, with or without a small conjunctival addition at its summit. The cutting of a con-

junctival flap necessitates a slight encroachment into superficial scleral tissue; otherwise the usual incision lies entirely in corneal tissue, and at the surface of the globe corresponds exactly with the sclero-corneal boundary.

FIG. 43.—SCLERO-CORNEAL SECTION, WITH CONJUNCTIVAL FLAP.

In Bombay the generally unsatisfactory or doubtful state of the conjunctiva, indicating the need for an effective covering to the wound, led to the routine inclusion of a somewhat unusually extensive conjunctival flap, about

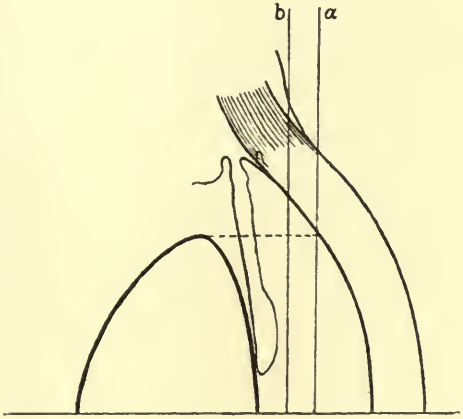

FIG. 44.—DIAGRAMMATIC REPRESENTATION OF PLANE OF INCISION.

(*a*) At the visible corneal margin, and (*b*) behind this, cutting into sclera and conjunctiva (modified from Czermak, 'Die Augen. Op.').

1·5 millimetres long at the summit of the arch, and tapering away at the sides of the wound. This involved the addition of a complete narrow rim of superficial sclerotic to the boundary of the corneal flap (Figs. 43 and

44). Feeling that this section might be more generally adopted with advantage, the following description is based primarily upon it. It is to be understood that the employment of a fairly complete conjunctival flap necessitates some provision for preventing or dealing with hæmorrhage into the anterior chamber—either the preliminary instillation of adrenalin solution, or irrigation of the chamber, or both. In Bombay, for the greater part of my time there, we relied entirely upon irrigation, but quite lately we made use of adrenalin more and more.

In defining the course of the incision, it is well to bear in mind that there is considerable variation in the boundary between cornea and sclera above. In some eyes the degree of overlapping of the deeper corneal margin by superficial scleral

FIG. 45.—OVERLAPPING SCLERA ABOVE.

tissue is—so far as one can tell clinically—precisely the same above as at the sides and below. In other eyes a thin layer of superficial sclerotic, with its covering of loose conjunctiva, comes forward over the cornea to a distinctly greater distance above than elsewhere. In the former case when cutting upwards in a plane parallel to the iris, an incision begun at the margin of clear cornea remains so; whereas in other eyes the knife, in making such a section, cuts upwards through some superficial scleral fibres and through loose conjunctiva.

The overlying strip of scleral and conjunctival tissue above is too thin to present clinically the opaque, white appearance of the neighbouring sclerotic. It is seen as a narrow, greyish-white crescent, with a fairly well defined upper boundary (see Fig. 45). In a few of the eyes met with in India bearing traces of old trachoma, this uppermost deep corneal boundary is the only recognizable division remaining between cornea and sclerotic. The limbus merges into the marginal opacity left by old pannus. This, however, matters little with regard

to our cataract incision, for one regulates the direction of the knife edge about the summit of the arch entirely by the conjunctival flap, according to whether it appears to need to be lengthened or shortened in individual cases.

Stellwag found the vertical measurement of the front surface of the cornea to vary from 9·5 millimetres to 12·5 millimetres, whereas the horizontal measurement varied only from 11·9 millimetres to 12·6 millimetres, and the boundary of the posterior surface was practically circular.

Most surgeons of experience, having taken up the position already mentioned, behind the patient's head, cut with the right hand upon the right eye and with the left hand upon the left eye, the other hand being occupied in fixing the globe. This plan of operation is assumed throughout the following lines, but it is not that best suited to the average right-handed beginner. The latter should use his right hand for cutting. For the incision in the left eye he must stand by the patient's left side.*

The Graefe knife, with blade 2 millimetres broad, is seized about the middle of the handle between the thumb and the index and middle fingers, much as one lifts a teaspoon. The cutting edge is directed towards one, and the back of the handle rests in the groove between the nail and tip of the middle finger. The other hand, holding the fixation forceps, obtains firm support across the patient's nose. The conjunctiva is gripped by the forceps below the middle of the cornea. A large hold is taken to lessen the chance of tearing; and it is as close to the cornea as possible, because at a little distance away from the cornea the inelastic senile mucous membrane may be too loose and mobile to serve in restraining the move-

* This position is for the making of the incision only, and is changed immediately afterwards. The surgeon displaces the assistant, whose services are for the moment not required.

ments of the eye. The degree of control secured should be tested by a lateral pull with the forceps; it is never absolute. The object of fixation is merely to retain the globe in the position which it has taken up. The eye is

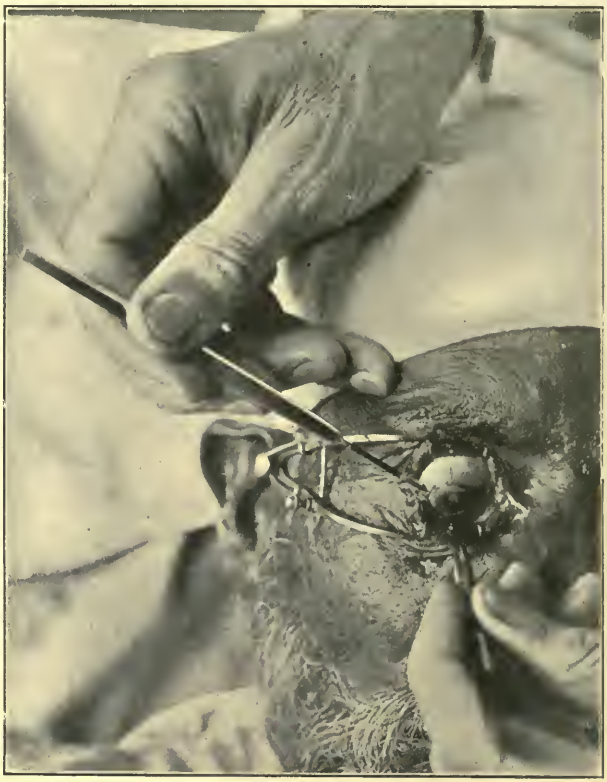

FIG. 46.—THE PUNCTURE.

Note the wrist resting against the patient's head; also the mode of holding the knife.

not to be pulled into position by the forceps, though during the cutting the grip of the forceps may have to resist a fairly strong upward pull of the eye.

The cutting hand is steadied by resting the tip of the

little finger against the patient's temple, with the fingers more or less in contact with one another. I can recommend to nearly all beginners, and to many experienced operators, additional support to control tremor of the hand. Free movement at the wrist is not required. The wrist is therefore carried inwards to rest firmly against the patient's head. The hand is thereby bent back at the wrist joint, and the point of the knife thrown somewhat downwards. The point, thus directed inwards and a little downwards* (Fig. 46), is inserted through conjunctiva and sclera ½ to 1 millimetre from the corneal margin, rather more than 1 millimetre above the outer end of the horizontal corneal meridian. In eyes with shallow anterior chamber the point must be directed a little forward to escape cutting the forward-arching iris, and therefore the puncture is begun a little farther from the cornea (fully 1 millimetre). But in ordinary cases the blade lies exactly in the transverse plane. The edge of the knife is directed straight upwards, in a line exactly parallel with the corneal margin, which serves to guide the knife. The sunken eyes of some emaciated patients, and eyes with palpebral aperture contracted by old trachoma, may have to be rotated somewhat inwards by the fixation forceps, to enable the blade to be placed correctly with regard to the eye, and at the same time to lie quite clear of the outer end of the upper lid border. The penetration of the tissues is made with deliberation, and the point of the knife swung up to the horizontal direction as soon as it is well within the anterior chamber. That the blade lies in

* Formerly, when stress was laid upon the advantage of a small linear incision in lessening the liability to suppuration of the wound, it was held to be correct to point the knife well downwards in making the puncture, in order that the wound should be as large as possible at the deep surface of the cornea. With the comparatively large section made nowadays this point is of less importance.

the anterior chamber is shown by its bright appearance and by its mobility.

If the anterior chamber happens to be very shallow, the point of the knife in passing slowly inwards has to be guided a little forward over the bulging iris; and, finally, in attaining the transverse plane, which it must do to reach the site of counter-puncture, the blade may have to press against the iris, indenting it. In such a case the swing of the blade may tend to cause a slight leakage of aqueous through the puncture.

Eyes which have been pulled inwards by the forceps, as above, are allowed to roll outwards again—at least, partly. This movement of the globe, while the knife is held stationary, takes the place of a portion of the movement of the blade ordinarily required as it crosses the chamber.

The point engages in the posterior surface of the cornea at the nasal side about ½ millimetre before its disappearance behind the scleral boundary. This brings the knife to the surface barely within the sclerotic, and not at the greater distance from the cornea* which one might anticipate. The site of this counter-puncture must be selected carefully, and corrected, if necessary, more than once by disengaging the point; but there must be no trace of hesitation on the completion of the counter-puncture, lest the aqueous begin to flow away. The knife must at once travel upwards with a steady, even, inward thrust, cutting equally on both sides of the cornea, to bring the blade well up in front of the iris, before the chamber can become emptied of fluid. Usually almost the whole of the blade is utilized in this first stroke; but in operating upon eyes either insufficiently turned downwards or purposely still

* The encroachment upon scleral tissue needs to be rather less at the inner end than at the outer end of the section, owing to the fact that the knife thrusting inwards tends to slip under the conjunctiva at the inner side of the globe.

rotated a little inwards (as above), the movement may be ended earlier by the arrival of the knife-point at the caruncle or neighbouring upper lid border. In other cases the point of the knife may possibly reach the side of the nose. A prick anywhere is likely to make the patient wince, and attempt to close his eyes, and even possibly move his head.

Other reasons for somewhat early arrest of the inward stroke may be met with occasionally: (1) a tendency for the outer part of the section to become misplaced a little forward, so as to lie entirely within the cornea; (2) the

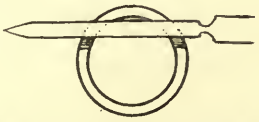

FIG. 47.—SECTION IN THE PLANE OF THE KNIFE, SHOWING THE END OF THE INWARD THRUST.

occurrence of prolapse of the iris through the inner portion of the wound, or a tendency thereto.

When not thus prematurely ended, the one thrust should suffice to bring the edge of the knife to the summit of the anterior chamber.* Yet still a good deal of tissue remains to be cut (see Fig. 47), nearly always more in our operations than can be cut easily in a single reverse movement of the knife.

More or less aqueous leaks away as the knife passes upwards, yet still a moderate quantity of fluid usually remains in the chamber after the completion of the inward thrust, when the latter is correctly made. Early loss of aqueous, in so far as it depends upon faulty incision, is due less to slowness in cutting than to alteration in the plane of the blade. Any slight twist of the blade, required as

* It must be confessed that in our Bombay work, with knives not as sharp as they might have been, in the majority of cases less than this was accomplished by the one stroke of the knife.

soon as one notices the slightest tendency to departure from the planned line of incision, of necessity prises the wound open a little and allows some fluid to escape. Other occasional sources of premature leakage, in addition to the sloping sclero-corneal puncture necessitated by a shallow chamber, already alluded to, are: (1) uneven faltering tension on the cutting edge, due possibly to movement or attempted movement of the eye, or to spasm of the lids, or to tearing of the conjunctiva by the forceps; and (2) partial withdrawal of the knife for any particular reason (see below). A rather quick stroke is advisable in eyes with shallow chamber, and whenever the aqueous is seen to be flowing.

In the brief rest which follows the first long thrust the opportunity is taken to note (1) the condition, and (2) the direction of the knife. Possibly some portion of the blade may have already touched the stumps of the cut eyelashes, or the upper lid border at either end. Or some rotation of the eyeball by the forceps, carrying the knife with it, may be advisable to remove the knife from risk of such contact during the completion of the section. This soiling of the blade* is frequent in operating on sunken eyes imperfectly rotated downwards, and it may be quite unavoidable in cases where the palpebral aperture is much

* Earlier fouling of the knife may be caused by sudden spasm of the orbicularis, bringing the outer part of the upper lid border into contact with the blade, in spite of the speculum. The contact may be only with the under surface of the knife, where one cannot see the soiled patch. If one has reason to suspect that this has taken place, it is better to withdraw the instrument than to risk infection of the wound. I remember doing this on two occasions only. Once, when the puncture only had been made, the cleansed blade was reinserted satisfactorily and the operation completed. On the other occasion the counter-puncture had also been made, and the patient was nervous and unreliable, so the eye was bandaged up and the operation postponed.

contracted* from old trachoma. And yet one dare not allow any soiled portion of the instrument to enter the wound. Where there is no difficulty of this kind, the section is completed by leisurely to-and-fro sweeps of the knife. But soiling of the blade at one or both ends may leave very little of the cutting edge available, and thus may shorten the movements very much indeed. Then a most helpful practice is to combine a rocking† motion with the sawing action of the knife. The section can be finished by very short thrusts with the knife pointing upwards as well as inwards, and withdrawals upwards and outwards (the knife pointing downward and in). Unless the surgeon be keenly alert with respect to this matter, infection may readily be carried from the lid margin into the wound, unsuspected.

There should be no hurry in completing the incision. During the sawing movements attention is directed to the outlining of the conjunctival flap at either side (see below), and this determines any slight forward or backward twist of the knife which may be necessary. The edge of the knife frequently has to be turned somewhat forward to follow the corneal margin above, as the wound tends to open. The blade at once slips upwards under the loose conjunctiva as soon as it gets through the firm sclero-

* Not only is the aperture small in these cases, but full rotation of the globe downwards frequently impossible, owing to anchoring of the eyeball by retraction of the fornices. In five marked examples of this condition I had to divide the outer canthus with scissors (at the time of the cataract operation) to obtain room for the play of the knife. Nowadays I should always operate upon such eyes by Czermak's subconjunctival section, with scissors.

† This rocking action of the knife tends to be added on to the to-and-fro movements without intention if the instrument be quite loosely held. I have frequently combined it when not really necessary, because with the anterior chamber empty it appears to complete the section with less rubbing of the iris than by simple transverse movements.

corneal tissue (see Fig. 48). If allowed to come through with a jerk, the patient may be startled and try to close the lids. To cut through the conjunctiva above, the knife

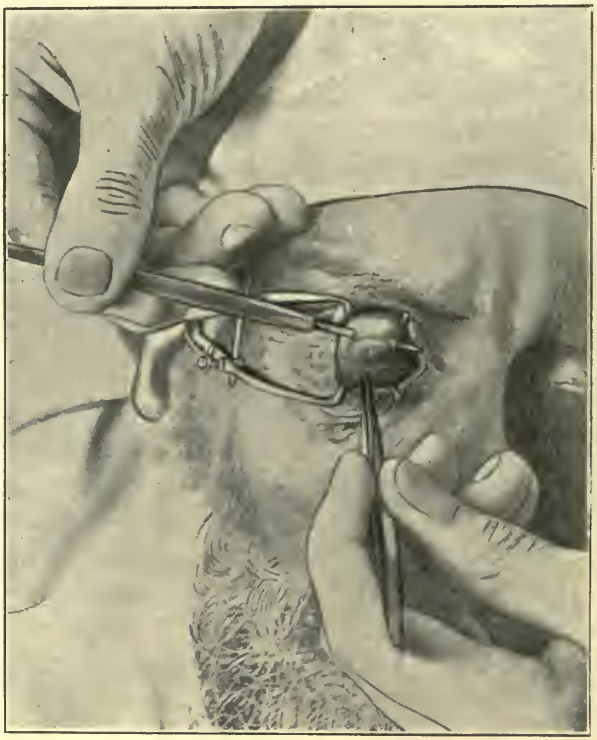

FIG. 48.—COMPLETION OF THE DEEP INCISION.

The knife edge must now be turned forward. The conjunctival flap will be larger than usual. (This is the same patient as shown in Fig. 46. Note the changed position of the hand. The palm is now partly seen.)

edge is turned forward at the selected distance above the cornea.

Only with a keen knife can due gentleness be assured in cutting. Fig. 49 shows the wrinkling and slight

distortion of the cornea, with displacement and elongation of the pupil, produced in some eyes by the slightest drag on the knife. From this it will readily be seen how the first reversal of the movement of the blade, altering the direction of the folds of the cornea, is commonly accom-

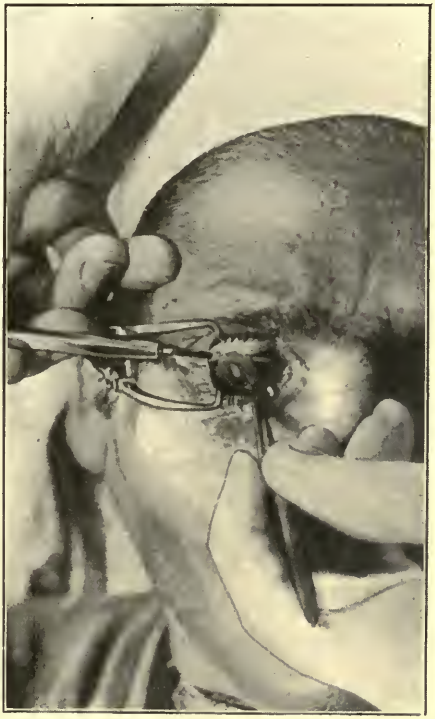

FIG. 49.—SAWING MOVEMENT OF THE KNIFE. OUTWARD PULL.

panied by a small gush of fluid from the anterior chamber. This occurs even though the pressure upon the edge of the knife be evenly maintained throughout, as it should be. The photograph also helps one to realize how the pull of a blunt knife, distorting all the neighbouring structures, may stretch and even rupture the underlying

zonule.* This risk of tearing the zonule still exists during the cutting of a large conjunctival flap. A broad strip of loose elastic membrane, such as is seen in Fig. 48, is by no means easily divided unless the knife be very sharp.† Several to-and-fro movements of the blade may be needed, during which the deep wound is pulled open. Blood from the episcleral vessels thus finds its way into the anterior chamber.‡ This occurred especially often in our Bombay work, because until lately adrenalin was never used, and an extensive flap (sometimes completely covering the

* An accident possibly signalized at once by partial dislocation of the lens and perhaps escape of vitreous, but possibly on the other hand passing unrecognized at the time, and giving rise to loss of vitreous later when pressure is put upon the eye to expel the lens. Twice in children and once in a woman of twenty years, among our operations, the zonule gave way, and escape of fluid vitreous occurred on completion of the section. (Only two of these operations, however, were flap extractions. The third was a linear extraction, the incision being made with a triangular keratome.) Particular care and gentleness are demanded to avoid causing loss of vitreous in making the incision for tremulous or dislocated lenses, also in congested glaucomatous eyes, both because of the vitreous tension, and because of the pain and consequent spasm of the lids likely to be produced by the knife rubbing upon the iris. Danger is also experienced in non-glaucomatous eyes with vitreous tension.

† One dare not pull much upon the conjunctiva. Repeated light sawing movements are effective, though their repetition may prove a little tedious. In one of our operations the drag of a rather blunt knife upon the conjunctiva appeared to be partly responsible for loss of sight in the eye. It was a case of black cataract in a highly myopic eye. While a large conjunctival flap was being cut the lens became a little displaced upwards, so that its equator presented in the wound. Though this was probably due to fundus hæmorrhage, it appeared quite possible that the pull on the conjunctiva was partly responsible for the hæmorrhage. The lens was delivered by a touch with the cystitome, and was immediately followed by vitreous. Next day the wound was found distended and the eyeball filled with blood-clot.

‡ The entry of the blood is due to the forward pull of the knife. This is shown by the fact that the chamber may be momentarily emptied by turning the knife edge upwards, while the chamber refills as soon as the cutting of the flap is resumed.

wound) was frequently cut in a conjunctiva congested by exceptionally free perchloride douching, both of these precautions—the conjunctival covering and the free perchloride treatment—being combined to guard against the one danger, infection from an unhealthy conjunctiva. By the time the flap has been cut, the knife exchanged for the irrigator nozzle, and the latter introduced into the wound, the blood in the chamber may have partly clotted and become adherent at one or more points to the iris firmly enough to defy attempts at complete removal by irrigation. (The clot is usually, however, partly expelled later with the lens.) Further hæmorrhage into the chamber may be prevented by turning the conjunctival flap down over the cornea, except in cases where the flap forms a complete covering. The lower portions of a complete flap, covering the sides of the wound, serve to direct the blood inwards.

During the earlier part of the cutting the surgeon's mind is fully occupied with the incision. As soon as he has time to notice the position of his hand, he will find that it has changed slightly from the position above described and shown in Fig. 45. The wrist has straightened a little and rotated, turning the palm of the hand more to the front (Figs. 48 and 49), and bringing its inner border close to the patient's head. The inner border of the hand—or of the little finger, if the patient's head be small and round—may now be pressed firmly against the head for support. This does not at all restrict the necessary movements of the knife, which are amply provided for by movements of the fingers, with slight pronation and supination at the wrist.

The above general description now needs amplifying by the consideration of slight voluntary and involuntary

variations of technique, and by the recognition of occasional difficulties.

The *right-handed* beginner should be in no hurry to cut with the left hand in operating on the left eye, and unless he is likely to operate much will be consulting his patients' interests by not acquiring the habit. Many experienced operators are content to cut always with the right hand. Most men will find that a very considerable expenditure of time in training and exercises will be necessary, apart from actually operating, to enable them to cut as accurately and easily with the left hand as the right. If one is prepared to give up the necessary time to the training it is doubtless well to use the left hand, for one has more natural and easy control over one's fingers in cutting towards one than away from one. But for myself, I must confess to a slight remaining clumsiness in using the left hand, revealed in results mainly by a larger proportion of irises cut by the knife in the left eye than in the right. In using the right hand upon the left eye the wrist is unsupported.

Fixation.—The pull of the forceps resisting the inward push of the knife sometimes raises a fold of conjunctiva covering the nasal margin of the cornea. This interferes with the accurate locating of the counter-puncture, and it also directs the knife-point far under the loose conjunctiva. The grip of the forceps may be momentarily released to enable one to see the point of the knife as it enters the posterior surface of the cornea, or a fresh hold may be taken farther outwards below the cornea.

Where the fornices are moderately retracted by scarring, the ocular conjunctiva may be rendered so tense by the speculum as to be difficult to seize by the forceps below the cornea. A much stretched conjunctiva is very liable to be torn by the forceps while the section is being made.

Other causes of tearing are—(1) straining of the globe upwards; (2) the use of forceps with too few or too long teeth; and (3) the brittle texture of some senile mucous membranes. One must finish the operation as best one can. Usually a fairly effective hold can be got elsewhere. But if the tear be a large one and take place early, and the eye perhaps unsteady, it may be very difficult to complete the incision without soiling the knife on the lid margin. The patient's co-operation in turning the globe downwards is essential for the correct use of the knife. However, the worst that has happened in our practice from this trouble has been the completion of the section by turning the knife edge forwards, and thus sacrificing the conjunctival flap. We have never used other instruments to replace the forceps, such as Pamard's spear, or other forms of double hooks, nor have we attempted to seize the internal rectus tendon, nor have we practised fixation with a broad conjunctival suture. Speaking generally, frequent tearing of the membrane by the forceps may be taken as an indication of insufficient training of the patients.

During the progress of the section, the beginner, with his attention wholly engrossed in the incision, may find that he is unconsciously pressing upon the globe with the forceps, forcing out aqueous and perhaps iris* through the wound. To avoid the liability to this mistake, it is sufficient to obtain a firm support for the hand, and to make sure that a slight forward pull upon the eyeball is being maintained with the forceps before beginning the incision.

The *size of the section* may frequently be reduced in combined extraction. A corneal flap 3 millimetres high,

* Possibly also vitreous on the completion of the section if the pressure be not relieved.

or slightly more, including about one-third of the corneal circumference, suffices for the easy exit of lenses with fully ripe soft cortex. In dealing with a Morgagnian cataract, supposing for any reason, such as the presence of capsular opacity, combined extraction is decided upon beforehand,* an even smaller incision is ample, and perhaps preferable, for the passage of the smaller nucleus. The full-sized incision is needed for lenses with firm cortex and dark (and probably, therefore, large) nuclei, and for all unripe cataracts.

No increase in size of the flap beyond two-fifths of the corneal circumference can be of any service in combined extraction. The base line of this section has practically attained the maximum, and the height of the flap is sufficient to permit of wide opening of the wound. And there is not the pupillary reason for a low base line, which applies in the simple operation (Chapter IV). One is inclined in combined extraction often to make the opening slightly larger than is really required, perhaps a little from the force of habit, if one operates frequently by 'simple' extraction, and still more from the general feeling that the evils of too small an incision are decidedly greater than those of an unnecessarily large one.

It is held that an incision including one-third of the corneal circumference is sufficient for the combined operation in patients under forty-five years, and that any increase beyond the actual needs of the case is to be avoided, because it predisposes to subsequent incarceration or prolapse of iris in the angles of the wound. For the iridectomy protects only a limited central portion of the incision from iris entanglement. And the sphincter of the pupil, considerably disabled by the iridectomy, is less able to retain the iris within a large wound than in simple extraction. It might be added that accidental reopening of the wound is more likely with a large section, but such reopening applies chiefly to the central part—viz., that guarded by the coloboma.

The drawbacks of too small a section are more obvious. And the enlargement of the incision with blunt-pointed

* Simple extraction is generally preferable for these lenses.

'secondary' knife, or preferably with scissors (*e.g.*, by Stevens' tenotomy scissors), though a little troublesome, is entirely preferable to squeezing a bulky hard lens through too small an opening, bruising the iris and the lips of the wound, stripping off cortex, and running the risk of rupturing the zonule by the amount of pressure necessary.

A somewhat smaller and less peripheral incision has been recommended in highly myopic eyes, and a proportionately larger section in eyes with small corneæ. But minute care in proportioning the section is uncalled for.

Intentional variation in the size and shape of the conjunctival flap is mostly in the direction of increase beyond the dimensions and design given above. We have to operate upon many eyes in which the provision of a conjunctival covering complete from end to end of the incision is specially indicated, to guard against infection. When the needs in this respect appear particularly definite, Czermak's or other sub-conjunctival operation should be done. But there are other eyes concerning which one may feel just a little doubtful. The conjunctiva may be secreting a little mucus, or there may be a little albumen in the urine, with a trace of œdema about the ankles, but not marked anæmia; or there may be some liability to prolapse of vitreous, shown by a tremulous or subluxated lens or 'vitreous tension,' or by nervousness and unreliability of the patient. The need for a protective covering to the wound is naturally greater where any two of the above indications are combined.

In making a complete conjunctival flap, though the site of puncture through scleral and corneal tissue remains unchanged, the conjunctiva is penetrated a little farther outwards. And in making the counter-puncture, the posterior surface of the cornea is not entered till the point of the knife is about to disappear behind the scleral rim. A very small alteration of the point of emergence of the blade through the sclerotic may be counted upon to result in a considerably greater alteration

in the site of perforation of the conjunctiva, owing to the tendency of the knife to slide under the conjunctiva here.

Apart from the hæmorrhage at the time of operation, the drawback to a large conjunctival flap is the separation of the underlying wound,* which takes place afterwards. At one time I attempted to prevent this by notching the apex of the flap, excising a small bit with scissors. In the combined operation iris and conjunctiva can be excised together. But the result was not altogether satisfactory, apart from the fact that protection of the wound is most needed at its summit. The notch frequently became filled up with lymph and blood-clot sufficiently to retain some aqueous, and so to permit of slight separation of the deep incision. And in simple extraction there was a slight tendency for iris to protrude at the site of the notch. The better way to prevent any noticeable separation of the sclero-corneal surfaces is to cut the flap very short —not more than a millimetre—over a considerable portion of its extent (Fig. 50).

Fig. 50.—A Complete Conjunctival Flap, shortened to prevent Gaping of the Deep Wound.

Involuntary variations in the section are comparatively small and infrequent, so far as the scleral and corneal tissues are concerned, but they occur almost constantly in the outlining of the *conjunctival flap*. One may ensure that the latter shall be complete or incomplete, but one cannot always regulate its length and extent at the sides of the section with any degree of exactitude. The elastic mucous membrane, fixed only at the corneal rim, gives to the slightest pressure. Perhaps the most frequent departure from the intended conjunctival outline is a

* This separation does not take place after Czermak's or other sub-conjunctival operation, in which the mucous membrane is kept normally tense.

broadening of the flap at the inner side, due to a scarcely recognizable deepening of the counter-puncture.

Small modifications in the boundary of the conjunctival appendage are, however, not usually of much importance. A defect or excess down the sides of the cornea can be partly compensated for by broadening or narrowing at the summit of the arch. Should the conjunctival fringe be quite absent down the sides of the incision, owing to straying of the knife into purely corneal tissue, it may be well to add to the area of the small apical flap, which is all that remains possible, by increasing its length considerably (Fig. 51).

FIG. 51.—A SMALL APICAL CONJUNCTIVAL FLAP, CUT LONG.

The making good of any deficiency of the conjunctival flap, recognized sufficiently early, necessitates turning the edge of the knife a litte backwards in completing the sclero-corneal section. To restrict the necessity for this movement of the knife as much as possible, one may utilize the following small observation: During the inward stroke of the knife the conjunctiva tends to be pushed into the temporal portion of the wound, and tends to be cut closer to the cornea there, while, on the other hand, the blade slides readily under the conjunctiva at the nasal side of the cornea, and the tendency is towards lengthening of the conjunctival fringe there. Exactly the opposite tendencies with respect to the conjunctiva are noticeable in withdrawing the knife. One may therefore enlarge the conjunctival flap a little by rocking the knife, as above described, so as to cut at the nasal side only during the inward movements, and to cut at the temporal side only during the return movements.

Deviations from the correct line of incision *in the cornea and sclerotic* are due most often to the incision being begun

with the plane of the blade at a slightly incorrect angle. It is very difficult to judge always whether the angle of the knife is absolutely correct until the whole breadth of the blade is engaged in the puncture. The error more often consists in the edge of the knife being turned a little forwards than backwards. It may pass unnoticed until the blade in its course upwards becomes a little displaced forwards into the cornea.

Another occasional source of slight forward displacement of the section is the obliquity of the puncture in eyes with very shallow anterior chamber. One is apt to forget that, since the oblique plane of the puncture (Fig. 52, *a*) rapidly merges into the transverse plane of the section above (Fig. 52, *b*), this upper portion comes to be placed a little in front of the superficial (posterior) end of the puncture line, just as it is a little behind

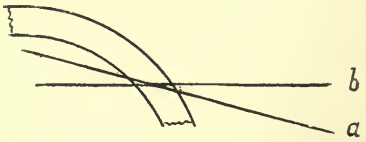

FIG. 52.—DIAGRAM TO SHOW (*a*) OBLIQUE LINE OF PUNCTURE IN AN EYE WITH SHALLOW ANTERIOR CHAMBER, AND ITS RELATION TO (*b*) THE TRANSVERSE PLANE OF THE SECTION ABOVE.

the deep (anterior) end of the line. Therefore, unless the superficial insertion of the knife be a little further back in the sclerotic than ordinary, according to the directions already given for these eyes, the knife tends to get in front of the limbus near the outer end of the wound. Should this have happened it is well to reverse the movement of the knife early, as it is easier to deepen the wound at the outer side of the cornea during the outward movement of the knife.*

A shallow anterior chamber may be responsible in another manner for a misplaced incision. In the somewhat hurried

* *Per contra*, during the inward thrust there is often perceptible a slight tendency to forward displacement of the outer half of the section. Possibly this slight tendency is absent when fixation of the globe is made with the forceps applied at the inner side of the cornea.

cut needed to avoid wounding the iris, one's attention being divided between the incision and the iris, the former may suffer.

It is especially in eyes with shallow anterior chamber that beginners, by puncturing too obliquely and too far forwards, may 'split the cornea' for a considerable distance. They may fail to notice the lack of that mobility and bright appearance of the blade which indicate its entry into the chamber. The opening into the chamber may thus be quite small, and the wound need enlarging considerably with scissors.

A cause of an incorrect section mentioned by up-country surgeons in India is the use of a 'whippy' knife—*i.e.*, an old worn instrument, which has become too thin and too narrow.

Straining of the eye upwards or spasm of the orbicularis muscle may also interfere with the exact execution of the section.

An ill judged deep counter-puncture and a knife held at an incorrect angle, with its edge directed a trifle backwards, are the causes of an incision too deeply placed, encroaching too much into the sclerotic. The evils of a very peripheral section (see Chapter IV) were much in evidence when von Graefe's 'modified linear' extraction was in vogue. Trouble from hæmorrhage into the anterior chamber is accounted for both by a broad conjunctival flap, and by section of larger and more numerous scleral vessels than usual. Impaction of the iris and capsule in the wound was doubtless the main cause of the destructive irido-cyclitis and sympathetic ophthalmia, to which the Graefe operation was found especially liable.

A small variation in the first thrust of the knife, either voluntary or involuntary, consists in sweeping up at the nasal side more freely than at the temporal side, using the knife like a scythe. The only trouble is a tendency to protrusion of the iris at the inner side below the knife, the iris being carried into the wound by the flow of aqueous there. On the other hand, it may be useful to carry the incision upwards at the inner side as far as possible, before an early reversal of the movement of the knife, necessitated by accidental forward misplacement of the temporal part of the section, already considered.

Other *troubles* associated with a shallow anterior chamber have to do *with the iris:*

1. The point of the knife, in passing across a shallow chamber, is apt to catch in the iris on the near side of the pupil. If only a minute strand of tissue has been taken up, it may be disregarded, as it will give way to the onward pressure of the blade. But if the point be more definitely engaged in the iris, to simply push the blade onward would often mean tearing a considerable portion of the iris away at its root, and necessarily, therefore, a very large and misplaced iridectomy. The instrument must be partially withdrawn to release it, and the further proceedings must be determined by the amount of aqueous lost in the withdrawal. Some authorities are very much against any reversal of the movement of the knife at this stage. But in my experience the needful withdrawal usually entails only a very small escape of fluid, or possibly none at all. And it may be accepted that unless the total loss of fluid is sufficient to bring the iris bulging quite forward above the edge of the knife, by the time the point of the instrument has reached the site of counter-puncture, the operation may be completed usually with only very slight injury to the iris. Should, on the other hand, the leakage of aqueous at this stage, or before, be deemed too great, there are two alternatives: adrenalin may be instilled and Czermak's scissor operation performed, or the operation must be postponed. In our work any postponement must be till the irritation from the perchloride douching has quite passed off.

2. A more common trouble—the cutting of the iris with the knife—mostly occurs in eyes with previously shallow chamber. Indeed, with a very shallow chamber one is perhaps more likely to cut the iris than not. But the small accident is also moderately frequent in other eyes, owing to premature leakage of aqueous bringing the iris forward in front of the edge of the knife, unless the blade

be unusually broad. The numerous incidents and conditions which lead to early emptying of the anterior chamber have been already mentioned. The knife may merely rub and scrape the iris, perhaps shaving off a thin layer of it. Or the iris may be 'button holed,' the piece removed extending through its whole thickness, but not reaching the pupillary margin. Or, in the worst cases, a complete coloboma may be made. This complete iridectomy made by the knife* has several disadvantages: (1) It is always unnecessarily broad. (2) I have found it frequently not symmetrical, sloping obliquely up and out. This appears to be due to the fact that the inward moving blade does not engage so early and readily

FIG. 53.—OBLIQUE IRIDECTOMY MADE BY THE KNIFE.

in the mobile central portions of iris as it does towards the periphery, where the membrane is firmly held. A strip of peripheral tissue (Fig. 53, *a*) is thus left at the inner side deprived of its pupillary zone. There is no sphincter muscle to pull this strip of iris into place, and this portion is consequently very prone to prolapse subsequently. I

* Bribosia (Transactions of the International Congress held in London, 1873) and Katzaurow (*Cbl. f. p. A.*, 1884, S. 370) purposely allowed aqueous to escape in order to simplify the operation by making the iridectomy with the knife. On the other hand, Bettremieux (*Arch. d'Opht.*, ix [1889], 79) modified the Graefe knife with the special object of avoiding any section of the iris. He gave it a projecting under surface to raise the edge from the iris. Kuhnt's and Critchett's knives were also designed for this purpose. And Czermak used a very broad Graefe's knife (3 to 3·5 millimetres) to avoid cutting the iris. Melville Black (Denver) prefers to withdraw the knife rather than damage the iris with it. After waiting for the aqueous to reaccumulate, he introduces a special probe-pointed knife to complete the section.

have several times noted this particular form of prolapse. (3) This mode of cutting the iris, with its accompanying rub and drag, is generally a little painful, and is therefore apt to provoke movement of the eye or blepharospasm. (4) A minor fault is that the pillars of the coloboma are left scraped and bruised.

Nearly all surgeons, when the iris comes forward above the knife, proceed as if nothing had happened, and the results are as just given. The bit of iris excised is removed with the iris forceps or washed out by the douche.

Prolapse of the Iris at the time of operation, unassociated with prolapse of vitreous, occurs almost exclusively in our experience through the nasal portion of the wound during the first long inward stroke of the knife. A tendency to prolapse, shown by elongation of the pupil, may be overcome by reversal of the movement of the knife; but since this reversal commonly empties the chamber of any remaining aqueous, it is not practised unnecessarily early. Should the iris have actually protruded, it is easily and completely replaced by the back of the blade of the knife, the point of the latter being well depressed. The outward movement of the knife is then made with the blade inclined thus upwards and outwards, as in the rocking action already described. The main objection to allowing a prolapse during operation to become large is that the stretching and nipping of the sphincter muscle in the wound must predispose slightly to a recurrence of prolapse after operation.

Any protrusion near the temporal end of the incision might be reduced in a similar way. Should the iris protrude above, from too sudden completion of the section, with or without pressure of the lids on the eye, the opportunity might be taken to perform the iridectomy

before returning the iris (if the combined operation were intended. This would not, however, suit those operators who prefer to seize the iris at its pupillary margin).

Among rare mistakes and accidents may be noticed:

1. The rather humiliating contretemps of finding that one has introduced the blade with its cutting edge downwards. I have had no personal experience of this, but have been saved from it on more than one occasion by the watchfulness of my assistant. It may be possible to rotate a moderately narrow blade 180 degrees while still in the puncture, without much escape of aqueous (according to Czermak and others). But most surgeons would prefer to withdraw it, and to attempt its reinsertion through the same opening (or parallel to it, Haab). The position and procedure are the same as are discussed on p. 84, the determining factor being the amount of aqueous lost.

2. Knives after resetting have on a few occasions been returned to us with very attenuated points. Once at least, a minute particle was broken off the tip and left in the tissues at the counter-puncture, without giving rise to any trouble. Terrien and others have mentioned similar breakages.

3. Once a sudden outward movement of the eye drove the point of the knife through the iris at the inner side. A little vitreous afterwards apparently found its way into the anterior chamber, though none entered the section.

4. In one memorable case I operated upon an eye with conjunctival fornices much retracted by scarring. The patient became excited at the close of the operation and jerked the eye about. The globe was so anchored to the lids that the movements pulled the wound open and ruptured the zonule. Loss of vitreous occurred, and was repeated next day at the first dressing, and the globe afterwards shrank. The only operations suitable for such eyes are the subconjunctival ones (Czermak's, Desmarres', etc.). It is well to bear in mind that fornices only a little retracted may be so fixed by the speculum that extreme vertical movements of the globe may tend to pull the wound open. This, however, is more noticeable with an ordinary downward section (Chapter IV) than with the upper one, because of the comparative shallowness of the lower reflection of conjunctiva. Where there is a moderate degree of

retraction the stretching of the ocular conjunctiva by the speculum may prevent any but a very small conjunctival flap being made.

A final word is necessary in closing this somewhat appalling and bewildering account of the difficulties which beset the accomplishment of an apparently simple step of the operation. The beginner cannot hope to bear in mind all the possibilities, but fortunately this is not altogether necessary. Though the intention be often imperfectly carried out, and though faults in the section be very obvious, the penalties incurred are seldom of any gravity except in two respects. The main essentials are (1) gentleness throughout, much facilitated by the use of a perfect knife; and (2) watchfulness against infection of the wound through soiling of the blade.

The temporal end of the speculum is now at once seized by the assistant, and the instrument thus raised, and ever afterwards kept elevated as steadily as possible. The fixation forceps are handed over to the assistant, who takes them in his disengaged hand. If, however, there is any decided tendency to spasm of the orbicularis, it is better to remove the speculum now and to trust to separation of the lids by the assistant's fingers, or, better still, to Desmarres' elevator for the upper lid and finger depression of the lower lid. In this case the assistant is not available for manipulation of the forceps.

Unless the speculum be raised promptly and maintained so, its arms, pressed down upon the globe by *spasm of the lids*, may force the wound open and be the means of producing a large loss of vitreous. Expulsion of vitreous may take place in spite of elevation of the speculum, but much less readily. The lids beyond the tarsi may still be pressed down upon the eye. The assistant in raising the instrument should take care that the outer canthus is pulled away from the globe, otherwise the

pressure of the outer end of the lids may tend to expel the ocular contents. The thrust on the speculum therefore may have to be a little outwards as well as forwards if the eyeball be prominent.

To minimize the tendency to reflex spasm of the orbicularis the patient must keep the other eye open, and in many cases his mouth also, and he must breathe regularly. Sometimes it may be necessary for an assistant to keep a continuous watch upon the patient with regard to these points. The instillation of cocain in the other eye has already been mentioned. (We have never practised it.) Should the patient show signs of pain when the iris is seized, it may be wise to remove the speculum and to wait for a couple of minutes while the effect of further cocain instillation is obtained. A few reassuring words from the surgeon may be useful at any time. But some of our poorèst patients failed to respond to kindness. Accustomed to rough treatment all their lives, they could be controlled only by sharp, angry tones.

Timid people often behave better during the actual operation if the Meibomian expression and conjunctival cleansing have been done a trifle roughly. The comparative quiet and gentleness afterwards are by contrast reassuring.

If the hospital arrangements are such that patients awaiting their turn are within sight and hearing of the operations being performed, it is most important to begin with the more docile and intelligent ones of the batch. Quiet behaviour of the earlier patients has a calming influence on the remainder, whereas trouble with a stupid person at the start alarms all the others.

One would expect, in operating on the second eye of a patient a fortnight or so after the first, to meet with quieter and more reasonable behaviour, but one generally finds the patient decidedly less reliable and less controllable.

Risk of reflex muscular contraction may be largely or entirely eliminated by suitable administration of drugs beforehand. We found sometimes that our patients had been made distinctly drowsy by chloral and bromide (p. 46). These overdosed patients could be relied upon to keep their lids at rest and their eyes steady, but they could not keep their eyes turned downwards. Timid, excitable persons may need narcotics or sedatives, but stupid, dull people may be made more stupid by them. Much assistance is derived in this respect from the

complete anæsthesia obtainable with combined adrenalin and cocain instillation.

To take charge of *Desmarres'* or other *retractor*, the assistant crosses over to the other side of the patient. Before inserting it behind the upper lid, now that the incision has been made, the lower lid must be retracted well first by the assistant's finger, and care must be taken not to let this lid slip while the elevator is in position. A strip of gauze or lint is interposed between the finger and the skin of the lid to prevent slipping. The assistant having only one hand available, the retractor is inserted by the surgeon and then handed over to the assistant, who draws the lid firmly upward and forward, resting his hand on the patient's forehead. In order to ensure that no portion of the lid muscle can still exert pressure on the globe, two points must be attended to: (1) The outer canthus must be removed from contact with the globe by the pull of the retractor; and (2) the eyebrow must be drawn up by the ring and little finger of the assistant's hand which holds the retractor. Smith of Jullundur insists on this point to "unroll, as it were, the orbicularis muscle, so that a clear field right up to the superior fornix is obtained."*

Czermak† advised the same drawing up of the brow during the use of the stop-speculum. It necessitates the use of the assistant's disengaged thumb, and can be accomplished without inconveniencing the operator greatly. But the assistant is, of course, not available then for fixing the eye.

A retractor may be used also for the lower lid, but it takes up a little room in the lid aperture.

As with the lid retractor, so with simple separation of the lids *by the fingers*, a fairly experienced assistant is needed. In both methods the palpebral opening may be scarcely wide enough if the eyes be deeply set (unless the eyes be well turned down). It is least wide by simple finger separation, and by this method also the elevation of the lids from the eyeball is least. And only very imperfect control over the orbicularis muscle is obtained. It is safer in this case to release the lids instantly when the muscle acts strongly, the eyeball rolling up.

A firm hold must be obtained by placing gauze or lint around

* *The Ophthalmoscope*, v (1906), 556.

† 'Die Augenärtzlichen Operationen,' SS. 908 u. 914.

or beneath the fingers, and care must be taken to press only upon the margins of the orbit, and not upon the eyeball. And the lower lid is the first retracted.

THE IRIDECTOMY.

For this step of the operation the surgeon takes up iris forceps in his left hand and scissors, preferably de Wecker's, in his right hand. To ensure freedom from risk of accident the eye must be fairly steady. A sudden upward movement while the ends of the forceps are within the globe might drive the points against the lens and dislocate it. Or with the forceps gripping the iris outside the wound, the movement might tear a considerable portion of the iris from its base, perhaps causing hæmorrhage and necessitating a very large iridectomy. The iridectomy is more likely to be a little painful than any other part of the operation. The pain is felt during the drawing of the iris out through the wound, and not particularly during its seizure and section. Pain is to be anticipated especially if the patient winces slightly when the fixation forceps seize the conjunctiva, or if rubbing of the iris by the knife during the making of the section has provoked evidences of resentment. In such cases it is safer to remove the speculum and to instil more cocain* and to wait for a couple of minutes, lest violent spasm of the orbicularis be caused by the iridectomy. In these patients, and in all who have shown restlessness or alarm, fixation of the globe by the assistant is essential, though ordinarily it may be dispensed with. A firm hold is taken upon the conjunctiva close to the inner side of the cornea, and the efficiency of the control tested by a pull upon the globe. Fixation, now that there is a large wound in the eye, is

* Mayweg (The Hague) prevents pain by instilling a drop of 1 per cent. cocain solution into the anterior chamber.

necessarily imperfect. The eye must be released whenever there is any strong attempt at upward movement, lest the pull should tear the zonule. Still, by restricting and delaying all movements the fixation forceps do much to ensure the harmlessness of the movements. If the operation be upon the left eye the assistant must use his left hand for fixation, his other hand being already occupied with the speculum. The fixing hand is then rather in the way of the operator. The wrist has to be overlaid by the operator's right wrist.

To ensure the easy performance of the iridectomy the eye must be turned downwards, unless it be unusually prominent. The operator's left hand, holding the iris forceps, rests on the patient's forehead. The right hand, holding the scissors, is placed in position across the patient's face, so that the two bades of the scissors are pointing upwards near the wound. The points of the forceps are introduced closed at the summit of the wound, pointing directly downwards. During the insertion they are kept free from entanglement in the loose conjunctival flap by slight lateral movements, and by backward pressure upon the sclerotic. Or the conjunctival flap may be drawn forward by the point of one of the scissor blades, after which the scissors are again placed in the position above mentioned. Should the conjunctival flap have been turned down over the cornea on account of hæmorrhage, it is left so, though if long it may prevent the operator seeing the points of the forceps in the anterior chamber.

Having arrived at a point midway between the base and pupillary margin of the iris, the forceps resting upon the iris are simply opened to a distance of 2 millimetres or less, and closed again, in the expectation that the iris will be thus seized. The instrument is slowly withdrawn through the wound, bringing a small loop of iris with it.

While this is being done the scissor blades, somewhat approximated (Fig. 54), are pressed down upon the incision, one on either side of the loop of iris. This tends to limit the size of the loop drawn out, and the scissors are ready in position to snip at once in case the eye should

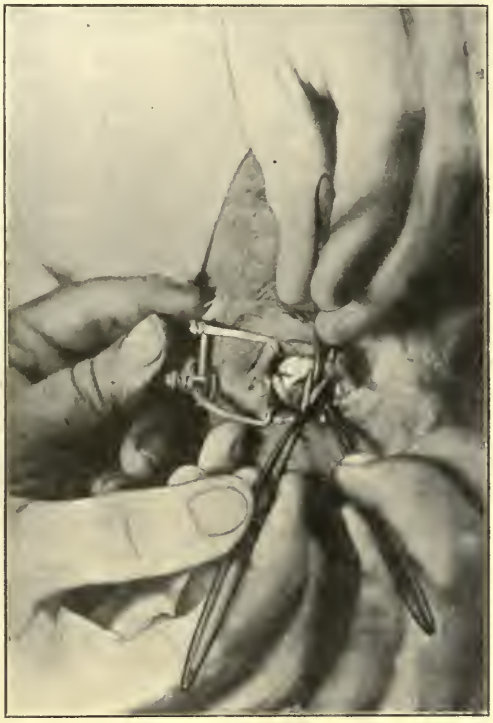

Fig. 54.—The Iridectomy.

begin to move upwards. And the conjunctival flap may be also thus pressed downwards, baring the iris. But if the flap is too large it may be left covering the iris, and some of it cut away with the iris. The pull upon the iris is continued until its pupillary margin lies between the scissor blades. The latter are then closed, and the iridectomy is completed.

There are many patients, however, who are unable to maintain the desired downward rotation of the globe. And it is a great mistake to worry the patient with repeated urgings to look down. For when control has been lost

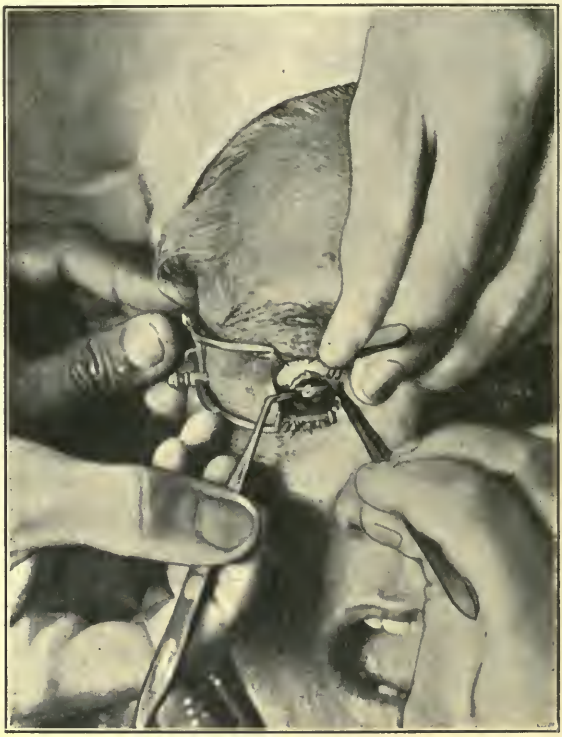

FIG. 55.—THE CORNEA IS FORCED DOWN BY THE IRIS SCISSORS, TUCKED INTO THE CONJUNCTIVAL FLAP, TO EXPOSE THE IRIS FOR SEIZURE BY THE FORCEPS.

to a great extent, the greater the movement of the eye from the position of rest, the earlier and more certain will be the recoil movement, passing beyond the position of rest. Even in the case of a deeply set eye, if it only be kept comparatively motionless, the iridectomy can be

done without any downward rotation, thus. The wound now lying behind the upper lid (which is pressed well forward by the supported speculum), the iris forceps can no longer be passed down through the incision. It is necessary that the wound shall be opened by displacing the corneal flap downwards, to expose the iris sufficiently for the forceps to be used with points directed laterally or backwards. It is to be reckoned as one of the definite advantages of a conjunctival flap that it furnishes a ready and safe means of thus opening the wound. The closed scissor points (de Wecker's), directed backwards or sideways, are utilized to push down the conjunctival flap. They readily obtain a hold upon the loose tissue, and thus enable the edge of the cornea to be forced downwards for a moment (see Fig. 55). The forceps points in gripping the iris need not enter the globe at all. The cutting of the iris must not be done with the scissors held transversely, as this would produce a wide coloboma instead of the very narrow one desired. Therefore no pull is made upon the seized iris until the scissors are in the correct position for cutting, lest slight pain excited by the pull should cause the eye to rise upwards. The iris must be quickly released when any movement of the globe appears too powerful to be controlled by the fixing forceps, lest a large irido-dialysis be produced.

There are three details which always deserve attention. Firstly, the iris should not be drawn out of the wound farther than is necessary, in order that the sphincter muscle may not be unduly stretched. (The stretching of the pupillary zone of iris is further reduced to a minimum by seizing the iris as above directed, at some distance from the pupillary margin.)

Secondly, no more iris is cut away than is essential to obtain a coloboma extending from the base of the iris to

the pupil. Thus as little of the sphincter is removed as practicable. Active sphincter muscle fibres are one of the chief preventives of subsequent prolapse or incarceration of the iris in the wound. They should suffice now to draw the iris back into position within the globe.

Thirdly, great weight has been laid by Knapp* and others (Horner, Snellen, Gayet, Alf. Graefe, Czermak) upon the necessity for immediate and complete replacement of the iris.

With the iridectomy performed as just described, spontaneous retraction of the iris is nearly always complete. In Bombay, therefore, no particular attention was found necessary in this matter. The means of replacement are given under 'Toilet of the Eye.' The readjustment must be repeated, if necessary, after the delivery of the lens and after the removal of cortical remains. But it is held that, provided the reposition is properly done after the iridectomy, it seldom needs repetition later. Inclusion of either pillar of the coloboma in the wound is shown by upward displacement of its projecting pupillary angle. Impaction of both pillars produces vertical elongation of the pupil. If they be allowed to remain in the wound during the expulsion of the lens, complete reposition afterwards may be impossible. For the sphincter is likely to become weakened temporarily by stretching of the iris, folded in front of the lens, and by the squeezing to which it is subjected between the lens and the cornea. The iris afterwards, nipped in the angles of the wound, may be further held by congestive swelling of the impacted tissue (?), or by transparent capsule lying in the incision.

Proper care in this respect is nearly always an effective safeguard against the complication which has been counted the chief reproach of combined extraction—subsequent incarceration of the iris in the angles of the wound, with its consequences, cystoid cicatrix, liability to late infection, etc.

Close approximation of the pillars of the coloboma, as a preliminary to expulsion of the lens, appears to be unnecessary, and even undesirable. It has been our usual practice to push

* *A. f. A.*, xi, (1882) 49.

the margins of the coloboma apart with the cystitome after making the capsulotomy, to make way for the lens, merely anticipating the widening which would otherwise be accomplished by the lens itself. The important point is that the iris should lie quite flat and even, without any tendency to entanglement in the wound.

Smith of Jullundur causes the iris to prolapse, and so avoids introducing the iris forceps within the wound. "He dimples in the cornea close to its free edge with one limb of the iris forceps, thus causing the edge of the iris to appear outside the wound; at the same time the other limb, which is resting on the sclerotic above, is slid along so that the iris is lightly caught in its grasp, pulled outside, and cut off in the usual manner."* (Axenfeld has caused the iris to prolapse similarly for the performance of iridotomy.)

During a cataract operation the contractility of the pupil is not usually demonstrable after the section has been made. But sometimes I have noticed considerable activity of the sphincter muscle after making such an iridectomy as above described, in operating for adherent leucoma. With the smaller wound, and the anterior chamber perhaps not completely empty, the lightest touch upon the iris with spatula may produce marked contraction of the pupil and coloboma, repeated as often as desired, drawing the iris away from the wound.

In attempting to remove as little of the sphincter as possible, one is very apt to *buttonhole the iris*, leaving a band of tissue separating the coloboma from the pupil. This is more likely to happen if the iris prolapses on completion of the section. The iris is then often seized too near its base. A bridge of tissue is also often left when the iridectomy is unintentionally made with the knife during the cutting of the section. The band is commonly too narrow to be gripped by iris forceps passed down in the ordinary way. It might be withdrawn by a Tyrrell's hook, rapidly sterilized in the flame; but the necessary rotation of the hook in catching and withdrawing the band is rather awkward with the left hand, and the instruments at hand suffice.

The narrow strip of tissue may be readily hooked upwards by the cystitome (held in the right hand) after the capsulotomy

* Rutter Williamson, *The Ophthalmoscope*, v (1907), 558.

has been done. If very narrow, it tears readily. Otherwise the loop is released, and the forceps and scissors again taken up. The forceps are used so that one blade passes down in front, and the other, generally more or less embedded in soft lens matter, behind the band. This will still be found lying near the wound, retraction being interfered with by the sticky lens substance. The points of the forceps being closed beyond the band, the latter may then be readily hooked up and cut away. Or if the eye be very unsteady the forceps may be dispensed with. The left hand may be usefully employed with the curette or expressing hook. Pressure is applied at the lower edge of the cornea, as for expulsion of the lens. The wound is thus forced open, and the little band of iris stretched and carried forward on the presenting lens, either into the wound or near it, so that it may be easily cut with scissors. Usually the strip of iris may be made to present sufficiently well for the scissor blades to be applied transversely, snipping off lens substance together with the iris. Should by chance a long tag be left attached to one angle of the coloboma, this shrinks afterwards, but forms a posterior synechia.

In cases where the iris has already prolapsed through the incision, it has been recommended to reduce the prolapse in order to seize the iris at the point desired for making the iridectomy. But this is an unnecessary prolongation of the operation, and is, perhaps, theoretically inadvisable on account of infective risks where the protruded iris has come into contact with the conjunctiva.

The presence of a number of posterior synechiæ does not alter the procedure to any extent. In order to tear away an adhesion, the iris is seized as close to it as possible.

If the eye be unsteady, it may be convenient and permissible to perform the iridectomy a little to one side instead of straight upwards.

It is surprising that the section of the healthy iris should give rise to no hæmorrhage. Bleeding is almost confined to cases in which the iris shows evidences of past inflammation. In glaucomatous eyes it might occur were the iridectomy not usually performed beforehand. Hæmophilia and atheroma of so high grade as to lead to bleeding from the blood-vessels of the iris are both too rare to need special consideration.

The object of the iridectomy is twofold. A minor service rendered is in facilitating the delivery of the lens by furnishing a direct passage upwards. Secondly, much more important, it renders prolapse of iris after operation much less frequent than it would otherwise be. It does this by allowing the lens to escape without stretching, and thereby weakening the pupillary sphincter, and still more, perhaps, by providing an open gateway for the later direct

FIG. 56.—'KEY-HOLE' COMBINATION OF COLOBOMA AND PUPIL.

escape of fluid from the posterior chamber—fluid which might otherwise carry the iris into the wound whenever the early adhesion of the latter were temporarily broken down.

The 'key-hole' combination of pupil and coloboma

FIG. 57.—COLOBOMA POINTED UPWARDS.

FIG. 58.—SPHINCTERECTOMY.

appears to obtain these objects in the fullest manner, while sacrificing but little of the valuable sphincter muscle.

Many operators—*e.g.* Galezowski *—perform only a partial iridectomy or 'sphincterectomy,' taking away only a small piece of the pupillary zone of iris. Or a slightly larger iridectomy is made, removing a piece of tissue widest at the pupil and tapering upwards to a point. The tissue excised is precisely that which can be least well spared, and the opening for gushes of fluid from the posterior chamber is absent, or least

* *Rec. d'Opht.*, 1892, p. 262.

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wide, where it is most needed. If not effective against prolapse and incarceration, the iridectomy might as well be omitted, except in cases of rigid pupil.

Chibret* and Dianoux (Nantes) reduced the excision of iris to the minimum by cutting with fine scissor blades introduced into the anterior chamber. No iris forceps were used.

Formerly, it was a common practice for the surgeon to share his responsibility with the assistant, the latter actually dividing the iris, the surgeon merely fixing the globe and drawing the iris out of the wound.

In von Graefe's peripheral linear operations under general anæsthesia the iris nearly always became prolapsed. A broad piece was removed by two snips of the scissors. Von Arlt, in order to avoid incarceration, made a very broad coloboma, dividing the iris with curved scissors along its base, and radially at the two ends of the incision. De Wecker† commonly made a narrow coloboma with his iris scissors (pince-ciseaux). It was pointed or with parallel sides, and extended to the base of the iris. This narrow iridectomy, recommended also by Swanzy and Fuchs as an effective preventive of prolapse, came to be adopted generally. In the making of a very narrow coloboma many surgeons have used an iris hook instead of forceps for withdrawing the iris.

THE OPENING OF THE CAPSULE.

The opening in the anterior capsule is designed to serve for the easy exit of the lens in one mass, and to provide a central clear space for direct vision. At the same time, it is well to avoid, if possible, leaving a loose flap of capsule above, liable to impaction in the wound. These ends may be attained by (1) simple division with some form of cystitome, curved needle, or sharp hook; or (2) tearing away a portion of the membrane with capsule forceps; or occasionally (3) the successive use of cystitome and forceps.

* *Rec. d'Opht.*, 1884, p. 77.

† 'Chirurgie Oculaire,' p. 57 (Paris, 1879).

Capsulotomy with cystitome or sharp lens hook. In the large majority of combined extractions I have been content with a single vertical or oblique incision or tear with Graefe's bent cystitome—an incision considered out of date by many authorities. It has been held that this toothed instrument, like the sharp lens hook, commonly tears the capsule instead of cutting it, and that all tears directed towards the wound are contra-indicated, in that the effect of any such pull of the tooth upon the capsule is to produce a pointed loose tongue of membrane, with base upwards, likely to be carried into the wound by the escaping lens. But for some years past I have been in the habit of examining the capsules of nearly all our patients before their discharge, and have not seen reason to alter our general plan of work.

Procedure.—The eyeball is again turned downwards, and the fixation forceps are necessary if the eye be unsteady. But in a quiet patient it is better to dispense with fixation, because it is now necessarily imperfect, and because it is more likely to be felt by the patient, and therefore more likely to excite attempts at movement, than the capsulotomy itself. I prefer to use always von Graefe's bent cystitome, employing for both eyes the one intended for use upon the right eye (Fig. 24 *a*). It is placed for introduction into the wound with its bent end portion directed transversely. Whichever eye be operated upon, the instrument is held in the right hand, its end pointing to the left and the sharp tooth directed upwards (see Fig. 59). The hand is supported on the patient's forehead. The sloping stem of the instrument, between the bend and the handle, is steadied against the tip of the left forefinger or middle finger. This horizontal presentation of the terminal portion of the stem—that which has to enter the globe—removes all risk of its touching the

upper lid margin or lashes, supposing the ordinary bar speculum be in use. But this direction is adopted and maintained as long as possible, mainly to guard against the risk of injury by the instrument in case the eye should unexpectedly roll upwards.

FIG. 59.—INSERTION OF THE CYSTITOME.
(The conjunctival flap happens to be turned down in this case.)

The end of the cystitome is easily inserted under the conjunctival flap, passed down in the chamber, and then usually changed in direction, swinging around the tip of the left index finger as a fixed point. In a perfectly quiet eye a long vertical cut may be made in the capsule, pass-

ing exactly through the centre of the pupil. For this the end of the cystitome is passed down *beyond the lower pupillary margin*, behind the iris. It is then rotated on its axis to direct the tooth backwards on to the capsule, and then somewhat sharply withdrawn upwards, to make the required capsular puncture and its extension upwards. Usually this single movement is effective if the capsule be not much thickened and the tooth of the instrument be moderately sharp and free from blood-clot. In lenses with soft cortex the puncture of the capsule is signalized by a forward movement of some of the contents, and in Morgagnian cataracts the escape of fluid is at once seen. In those with firm cortex the impression of the point of the instrument in the cortex may usually be seen, unless it it is obscured by blood in the anterior chamber. If there is any doubt about the opening of the capsule, an up-and-down "scratching" movement of the cystitome is added. A horizontal movement of the instrument to either side near the wound serves to ensure a wide opening of the slit in the capsule, and to separate the pillars of the coloboma of the iris. The cystitome is then again rotated, so that the tooth points sideways. It can then be withdrawn from the wound. It is most important throughout to avoid pressure upon the lens, likely to displace it backwards, rupturing the zonule.

The ordinary short tooth, 1 millimetre or less in length, is used pointing directly backwards. Some cystitomes are made with distinctly longer teeth. A rather long tooth must point only obliquely backwards* lest it become embedded in firm lens substance, displacing the lens upwards and tearing its suspensory ligament, or lest

* A minor disadvantage of the long tooth directed very obliquely is that one cannot see exactly what portion of the slanting edge of the tooth is cutting the transparent capsule, and so one has not perfect command over the location of the incision.

the direct pressure of the tooth, working in an empty anterior chamber, depress the lens and thus rupture the ligament. A slight upward displacement of a lens with a firm cortex is not uncommon even with a short-toothed instrument. It is merely sufficient, however, to place the upper margin of the lens behind the scleral lip of the wound. And if recognized, or even suspected, it can be at once rectified by a small downward stroke of the cystitome.

In operating on a Morgagnian cataract the oblique direction of a long 'tooth' is essential also to avoid the risk of puncturing the posterior capsule on the collapse of the sac.

Blood-clot in the anterior chamber is a minor trouble. It prevents one seeing what is being done, and unless the cystitome happen to be insinuated quite behind the coagulum, the tooth becomes entangled in it and thus prevented from cutting. Yet one may prefer to proceed at once with the capsulotomy rather than make any prolonged attempt to wash away the clot with the douche. One must use the cystitome with to-and-fro scratching action to penetrate the hidden capsule. Perforation of the membrane will be shown by the appearance of cortex in the clot beside the cystitome, if the cortex be soft. But in lenses with firm cortex there is no immediate evidence of perforation obtainable in these cases. A sharp cystitome is advisable. And since one must work by the sense of touch alone, little more than the weight of the instrument should be allowed to press on the lens. After three or four up-and-down movements, one may assume with a fair degree of certainty that a sufficient opening has been made. One proceeds to express the lens, and one relies upon refusal of the lens to pass upwards as evidence that the attempt at capsulotomy has failed.

Another difficulty lies in restlessness of the eyes. Since uncontrolled movements of the globe are nearly always primarily upwards, there may be considerable danger in introducing an instrument far within the globe, directed vertically or nearly so. Therefore, unless steadiness of the eye can be confidently expected, the cystitome must only point obliquely, and if the eye be very unsteady the direction of the instrument can depart but little from the horizontal. And these inclinations are the only ones available in patients who cannot at this stage any longer look downwards. The tooth, with flat sides and single cutting edge, can only be expected to cut by withdrawal movements in the line of the stem. A long oblique, or even transverse, division of the capsule furnishes an opening perfectly satisfactory for vision, provided that it passes through a point a little *below the centre of the pupil.* Indeed, the direction of the cut appears to be immaterial provided its position is correct. In a large proportion of cases the elastic retraction of the membrane cannot be depended upon to effectually widen the slit. If an oblique cut be made across the pupil, the lower leaflet of the anterior capsule will frequently remain in position, only the upper leaflet being permanently displaced upwards and to the side behind the iris. Unless the line of division pass below the centre of the pupil, the edge of the lower portion, therefore, lies across or near the line of vision, uniting with the posterior capsule, and disturbing sight by opacity developing in its epithelial lining. This single-leaf displacement may be anticipated frequently even where the deviation of the line of incision from the vertical is quite moderate.

Though the instrument lie in the chamber obliquely, it may, if preferred, be withdrawn vertically in an attempt to tear the capsule vertically with the side of the tooth,

especially if the capsule be thin and transparent. But such tearing is apt to be productive of loose points of capsule liable to impaction in the wound.

It is necessary now to consider how the single long incision or tear, preferably vertical or nearly so, fulfils the requirements laid down.

Knapp* believes that "the vertical splitting is unfavourable for the exit of the lens; the horizontal, parallel to the corneal section, offers its easiest escape. . . . The next and worst drawback of the vertical splitting is that it produces a more or less dense scar, which is much in the way of the light, and which is very unpleasant to divide by a later capsulotomy. Graefe made not only a vertical split in the capsule, but also a horizontal one at the periphery of the coloboma. He opened the capsule horizontally in the upper part with a cystitome, which he then turned, and with it ripped the capsule from below upward to meet the horizontal incision. In this way he obtained a broad T-shaped opening, which did not always remain large enough, and my imitation of his procedure in Heidelberg and in New York proved no more obliging."

The single slit is evidently the simplest procedure applicable; it necessitates the retention of the instrument within the anterior chamber for only a very short period of time. Thus, we never had to chronicle accidental dislocation of the lens from movement of the globe, driving the lens forcibly against the instrument. The deliberate manipulation by some operators with the cystitome or hook directed downwards far within the chamber, appear to indicate that the average European patient is much quieter and more reliable than in Bombay. In most of our work the risk of accident from prolonged insertion of the cystitome certainly appeared to outweigh any possible benefit from an elaborately planned capsulotomy. We had to be constantly wary to withdraw the instrument quickly on any movement of the globe.

And it is well recognized that in working upon a practically invisible and more or less elastic membrane, additional movements of a toothed cystitome after the first opening has been made may serve merely to widen the opening instead of

* *Amer. Journ. of Ophth.*, September, 1905.

incising the capsule afresh. The sharp point must be carried well away from the primary incision to puncture afresh for any additional division.

We frequently used a cystitome with tooth blunted from numerous passages through the flame of a spirit-lamp. Yet sub-

FIG. 60.—**Y**-SHAPED CAPSULAR OPENING. (About two weeks after operation.)

sequent evidences of incision, as distinct from tearing, were quite numerous in the forms shown in Figs. 63, 65, 66, and 67. Until we realized how frequently the displacement of the capsule is due, largely or entirely, to the passage of the lens, we several

FIG. 61.—**V**-SHAPED OPENING, WITH TONGUE OF CAPSULE ABOVE. (Seen on discharge from hospital.)

times had to 'needle' after an oblique incision, passing across the centre of the pupil, simply because of insufficient displacement of the lower leaf, as shown in Fig. 64. Doubtless the blunt point frequently tore the membrane, however, and this

FIG. 62.—**V**-SHAPED OPENING. MARGINS SHOW A DEPOSIT OF FIBRIN. ANTERIOR CAPSULE SHOWS SLIGHT PUNCTATE OPACITY. (Eight days after operation.)

probably accounted for many triangular openings, as in Figs. 60, 61, and 62, with apex downwards and base generally not visible. That this form of opening had resulted from a **V**-shaped tear of the capsule is evident in Figs. 60 and 61, from the displaced tongue of membrane seen above. But usually no such projecting piece of membrane could be seen

above, and the opening (Fig. 62) might well result from a vertical or oblique incision, plus a horizontal tear above. Both the tear and the widening of the vertical slit above may result either from the lateral movement of the cystitome or from the

FIG. 63.—OBLIQUE INCISION IN CAPSULE, PARTLY BORDERED BY PIGMENT. (Eleven days after operation.)
a. Cortex.

passage of the lens, and the permanent widening of the slit may be maintained by the posterior synechiæ seen in Fig. 62 at the angles of the coloboma. Some of these openings were

FIG. 64.—OBLIQUE INCISION, TOO HIGH. LOWER LEAFLET NOT RETRACTED. (Eleven days after operation.)
a. Cortex.

defective from being too highly placed (Fig. 61). The short incision or tear was made either with the point of the cystitome entangled in blood-clot, as already mentioned, or with blunt

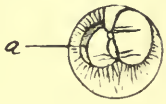

FIG. 65.—NARROW SLIT, WITH ADHESIONS TO POSTERIOR CAPSULE PRODUCING TRANSVERSE FOLDS. (Sixteen days after operation.)
a. Cortex.

point sliding over the surface of the membrane a little before engaging in it, or possibly the eye was unsteady and the instrument not introduced far enough within it. Fig. 63 shows a minor degree of defect, and Figs. 65 and 66 a more marked degree from inelasticity of the capsule, the edges of the slit

having come nearly into apposition. This was most often seen after operation for Morgagnian cataract with punctate capsular opacity. Fig. 67 shows also a narrow slit, the margins having possibly become drawn together by contracting blood-clot and lymph.

These narrow apertures are the only ones in which it is evident that the single division of the capsule in one straight line failed to provide a clear space, such as might more reason-

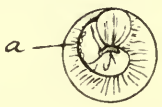

FIG. 66.—NARROW SLIT ENDING IN AN OPAQUE BAND BELOW, APPARENTLY FIBRINOUS. MARKED FOLDING OF CAPSULE. (Twelve days after operation.)

a. Cortex.

ably have been expected from complex or multiple division. In rare cases also of tough capsule the simple straight incision, insufficiently widened by the cystitome, resisted appreciably the exit of the lens during operation.

Figs. 81 and 82 show very large capsular openings. In other cases no anterior capsule could be seen; either it was perfectly transparent and colourless, or it had retracted so completely as to be hidden by the iris, even though the pupil was dilated.

FIG. 67.—NARROW SLIT OCCUPIED BY FIBRINOUS DEPOSIT, FORMING A BAND OF OPACITY. MUCH FOLDING OF CAPSULE. (Twenty-three days after operation.)

It was very rarely that we were able to detect any incarceration of capsule in the wound or adhesion to it—so rarely that the mode of opening the capsule could scarcely be blamed. In eyes with 'vitreous tension' and after prolapse of vitreous there must at times be some impaction of the capsule. Becker has shown that entanglement of points of capsule is not always recognizable clinically; but such cases are the least likely to give rise to trouble, especially when the site of entanglement is covered with a conjunctival flap. If, then, our simple division

of the capsule predisposed to impaction, the predisposition was evidently overcome by replacement of the iris at the close of the operation and by its retention in position by an active and nearly complete sphincter muscle.

Speaking generally, the question of the precise scheme of capsulotomy to be adopted has lost much of its importance since the early treatment of after-cataract has become so safe and effective (see later). Still, it is doubtless advisable to avoid unnecessary supplementary treatment, and with this object the opening in the anterior capsule should extend well below the centre of the pupil.

In simple extraction long incisions are not quite so readily made, and are generally replaced by movement of the point of the instrument in more than one direction. The iris above should serve to prevent tags of capsule from forming adhesions to the wound, though apparently it has not always done so.

Various incisions have been planned by numerous operators, many of them probably very imperfectly carried out. Von Arlt tried to make a **V**-shaped division of the capsule with a sharp hook. Von Graefe also at one time aimed at a **V**-shaped opening ; later (1870) he attempted to outline a large square in the centre of the membrane. Weber (1867) made two horizontal tears with a double hook. Czermak, by two horizontal tears in opposite directions, aimed at the formation of two flaps, one with base inwards, the other with base outwards. "Scratching" the centre of the capsule in different directions has been the method of many surgeons. Knapp objects to this, as especially productive of small shreds of capsule likely to unite with the border of the iris. The formation of adhesions is favoured by the numerous minute ruptures of the iris which occur during the passage of the lens in simple extraction.

Many surgeons have used slightly curved needles for dividing the membrane. The Moorfields pattern cystitome is shown in Fig. 25. Hess uses cutting forceps.

L. Müller* performs the capsulotomy before the iridectomy

* *Kl. Mbl. f. A.*, (1902) xli, 358.

in order that the upper part of the capsule may become a little folded up behind the iris, and thus kept away from the wound.

The consideration of other modes of opening the capsule is relegated to Chapter IV, either because the methods are not very commonly practised, or because their consideration comes better after the description of simple extraction.

The toughened, thickened, and opaque capsules of some overripe cataracts demand special consideration.

In Morgagnian cataracts, especially those with opaque capsules, the incision must be made with an unusually quick movement, and the point of the cystitome must be sharp. Otherwise the soft, but frequently tough, sac of fluid may be merely indented by the instrument, and perhaps pulled about by it. Or, more frequently, a small, insufficient puncture is made. This is because the rapidly emptying sac recedes from the cutting point quite early. Fearing lest this may take place, some slight attempt may be made to enlarge the aperture by movements of the cystitome in various directions while still some fluid remains within the sac. But if the capsule be opaque, this attempt is often unsuccessful. Any prolonged use of the instrument might lead to puncture of the posterior capsule unless the nucleus were sufficiently large to protect it, and free movement might, by pulling on the tough capsule, rupture the suspensory ligament. Because of the difficulty experienced in enlarging a small aperture, it is well always to make the primary cut in a Morgagnian capsule horizontal.* The opening often has to be finally expanded, with trouble and some slight risk, by the escape of the imprisoned nucleus, forced out by continued pressure and counter-pressure upon the globe. And this is

* Knapp's "peripherics plitting" above (see Chapter IV) is especially applicable to Morgagnian cataracts, except in that the later discission of these inelastic capsules required for visual purposes sometimes provides only a narrow opening.

least easily accomplished if the small puncture be situated below. For then the nucleus tends to slip upwards away from the opening whenever pressure is placed upon the eye.

The dense, indivisible central opaque plaque of some overripe, generally discoid, cataracts commonly requires removal by the use of both cystitome and forceps. Intracapsular extraction of the lens may be preferred in quiet patients by many surgeons. But I believe that the safest procedure is the most conservative. The capsule is first scratched through below the patch.* If the latter be then hooked up by the tooth of the cystitome, the membrane on either side is partly torn. The patch may then be readily seized with iris forceps, and, if the remainder of the capsule be nearly normal, slowly withdrawn. The tearing away of the central portion of capsule is much more likely to be successful at this stage than later, since the lens *in situ* affords a certain amount of resistance to the pull of the forceps. Should, however, the surrounding capsule be also somewhat thickened and opaque, indicating the probability of extension of opacity to more or less of the posterior capsule also, the membrane is likely to prove more resistant than the zonule below. To avoid rupturing † the zonule in these cases the pull of the forceps must be light, and must be given up as soon as a sufficient opening has been made for the expulsion of the lens. The extraction of the opaque capsule as a whole may then easily be accomplished at the close of the operation, after the removal of the speculum.

* Snellen recommends for this purpose a fine round needle, the extreme point of which is bent over at an angle of 90 degrees (see Haab's 'Operative Ophthalmology,' p. 150).

† Should this accident happen, the lens and capsule must be extracted together by the pull of the forceps, aided by an upward push with curette or hook on the surface of the cornea.

The same practice may be adopted for some very over-ripe juvenile cataracts, mainly capsular, in which there may be an anterior patch of great density. The extraction of this layer of membrane is much facilitated and freed from risk by preliminary cuts below and at its side.

There is still another form of cataract requiring special mention—the previously Morgagnian cataract, with all the fluid absorbed, consisting merely of the nucleus in a shrunken sac, the capsule often quite transparent, and the whole lens being possibly more or less tremulous. The nature of the cataract may have passed unrecognized until the iridectomy has revealed a dark clear space above the shrunken nucleus. I believe the safest procedure is to begin in the ordinary way.

A cautious attempt at capsulotomy is made with a sharp cystitome passed in from the side. Here the iris intervening between the cystitome and the zonule and loose capsule prevents injury to the latter. If the instrument were passed down from above at the site of the coloboma, its point might readily tear or puncture the thin membranes which alone cover the vitreous in this situation. An attempt is made to scratch through the anterior capsule where it overlies the nucleus with the tooth directed only a little backwards. In a quiet patient it appears to be almost immaterial whether this attempt is successful or not. More often I think it fails, and instead of the capsule giving way, the suspensory ligament below, and probably more or less at the sides also, is torn. This greatly facilitates expulsion of the lens in its capsule. Sometimes a mere puncture is made in the capsule, and the zonule torn also. One cannot be quite sure what has happened sometimes until an examination of the expressed nucleus shows whether it has escaped with or without the capsule. Should the opening in the

capsule have proved adequate for the exit of the nucleus alone, the untorn posterior capsule and zonule may be of great advantage in an excitable patient. The intact diaphragm may serve to prevent a large loss of vitreous.

THE DELIVERY OF THE LENS.

This is the step of the operation in which restraint and patience on the part of the operator are most needed. The lens is expelled from the globe mainly by instrumental pressure applied about the lower border of the cornea. By this means the intraocular pressure may be increased, the wound forced open, and the lens tilted to present its margin in the wound, while the localized indentation of the globe helps directly to displace the lens upwards. Continuance of the pressure tends to cause the lens to move slowly upwards, pushing the pillars of the coloboma to either side, to enter and to fill the wound. The further movement required to complete the passage of the lens out of the eye is facilitated by movement of the expressing instrument upwards over the cornea, following the lens, and more especially by the distribution of the pressure and indentation to either side as well as directly below the lens. Further, the hard coat of the eye is sufficiently flexible to allow of the expressor being sometimes used to actually push the lens substance upwards. The effect of repeated light upward strokes on the surface of the cornea is particularly noticeable upon the nuclei of Morgagnian cataracts, and rather less so upon some small thin lenses, and upon cortical matter remaining after the bulk of the lens has escaped.

Whether the hook or the spoon be selected (see p. 36), it is applied at first obliquely, so that only a portion of the curve is in use, the handle and stem inclining upwards

and somewhat forwards. The angle at which the instrument is used is altered later, according as one may need to utilize the two ends of the curve for lateral pressure or the convexity for pushing strokes upon the cornea.

The expressor is held in the right hand, and assistance is rendered in one or several ways by the operator's other hand. In combined extraction the left hand can be most advantageously employed with fixation forceps, used not only directly to aid in expression, but also for subsidiary small manipulations more or less helpful. The patient should still keep the eye turned somewhat downward, unless the eyeball be unusually prominent.

For all distinctly unripe cataracts it is, I believe, important, and for most lenses with soft cortex advantageous, to seize the conjunctiva below the cornea with the forceps* as the first step. By a downward pull, together with very slight backward pressure of the forceps, the wound is made to gape a little. The lower lip of the incision is displaced forwards, and the cornea somewhat flattened, so that its posterior surface may serve as an inclined plane to direct the lens into the gap above, while any pressure exerted by the forceps quite below the lens, indenting the globe there, must tend to displace the lens upwards. As soon as the section is found to open evenly thus, the expressing instrument is laid upon the lower edge of the cornea with gradual pressure backwards. In dealing with unripe cataracts the use of the two instruments should usually be continued together thus until the lens has begun to move upwards into the wound. In

* The grip of the forceps is at least temporarily released on any involuntary straining of the globe upwards. And this use of the forceps is dispensed with altogether in tense eyes, in which the lens is pressed forwards, and in the case of individuals with tense eyelids, which are not drawn forward by the speculum sufficiently from the globe.

other cases the forceps may be removed as soon as the pressure of the hook (or spoon) suffices to keep the incision open.

For lenses with firm cortex, especially overripe cataracts, thinned particularly about the equator, the above manipulation is not quite so well suited. The fixation forceps may be utilized otherwise. These lenses are very apt to slip upwards behind the wound instead of presenting in it. It is usually better in dealing with them to begin at once with backward pressure at or a little above the lower edge of the cornea, while the conjunctival flap is seized by the forceps and the wound thereby opened for a moment. One is thus enabled to see whether the lens is in correct position. Its upper border should be readily seen tilted a little forward by the pressure below, and ready to engage in the wound. If the equator of the lens is not thus seen, it is practically certain to have become a little displaced upwards behind the scleral lip of the wound, possibly having been pulled up by the cystitome during the capsulotomy.

This opening of the wound by the forceps is often of some slight direct advantage, since there may be already a tendency to gluing of the conjunctival flap down by means of blood-clot, particularly in cases where there has been some slight delay at any time after the completion of the section. This pulling of the corneal flap forwards may be repeated at any time as a possible aid to the exit of the lens. (But in operations where the forceps have just been used upon the conjunctiva below the cornea, possible doubts concerning the sterility of the conjunctival surface suggest that the forceps should not be applied about the wound margin without being cleansed upon the lint in the bowl of lotion kept at hand.)

If it is found that the lens margin has slipped upwards

behind the wound, or tends to do so, it may be easily pushed down again by the convexity of the hook or the edge of the spoon applied on the corneal surface close below the wound. There is usually no need to reintroduce the cystitome within the wound for this purpose. The upper lip of the wound is then depressed by running the closed ends of the forceps lightly along the sclerotic above the wound from end to end, while the upper edge of the lens is tilted forward by the application of the convexity of the hook on the lower part of the cornea. As soon as the lens border presents in the wound there is no longer need to keep up the depression of the sclera.

This upward displacement may not be always easily recognizable in operating without a conjunctival flap, and therefore without the means of opening the wound to look within. It may be suspected when pressure applied to the lower part of the cornea has little effect upon the wound—when the tilting forward of the lower lip of the incision is very slight and more or less uneven.

Should the source of trouble pass unrecognized, and should reposition not be effected, an attempt at introduction of a loop or spoon behind the lens may cause the latter to revolve on its horizontal axis, the lower edge coming forwards and upwards to escape first, and there is likely to be loss of vitreous.

Should lateral movements have been practised with the cystitome, some slight lateral displacement of the lens may have been caused. The displacement should be corrected by pushing strokes over the corneal circumference before the delivery of the lens is attempted.

Whatever be the variety of the lens, as soon as its equator has engaged in the wound the forceps may further directly assist in moving the lens upwards by light pressure, or rather counter-pressure, at the left lower

margin of the cornea, while the hook or spoon is applied, with more or less rocking movement, at the lower and at the lower and right margin. Either the closed ends of the forceps may be used (see Fig. 68) or, in operating on the left eye, the flat of the blades applied obliquely. The

FIG. 68.—EXPRESSION OF THE LENS.

The nucleus is seen already lying on the outer canthus, and cortex is issuing from the wound.

weight of the two instruments distributed thus over a wide area below appears to combine the greatest efficiency with safety. After the lens has slowly passed upwards, occupying the wound, the hook or spoon follows, pressing, if need be, alternately on either side. The bulk of the lens may finally be caught by the forceps as it escapes, or

may be lifted out of the wound by the forceps (or if the spoon be used, the lens is received and removed in its bowl).

Unless the sclero-corneal section be of full size, the sharp edge of a large firm lens may carry the pillars of the coloboma folded over it into the wound, nipping the iris between lens and cornea. But we have seen very little of this, owing to the regular use of a sufficiently large incision, and perhaps also owing to the making of a deep coloboma up to the base of the iris. In eyes with marked vitreous tension, however (see below), it is not always possible to avoid the entrance of iris into the angles of the wound.

The above description of lens expulsion differs from the practice usually followed, which is the same in combined extraction as in simple extraction. Continuous counter-pressure above with spatula or curette is combined with pressure below. The less peripheral the section, the more necessary is depression of the upper lip of the incision to guide the lens forward. But it is not needed, as in simple extraction, for drawing the iris backwards. And the path of the lens is more directly upwards. Acute watchfulness is required in the use of counter-pressure above, lest by sudden upward movement of the eye the instrument be carried into the wound.

For fully ripe cataracts the exact method of expulsion matters comparatively little in the combined operation. But in expressing cataracts in the least degree unripe it is important that no trace of sticky cortex be left in the lower periphery. It must be displaced up with the body of the lens, otherwise later efforts to remove it will probably fail. And for this purpose I have found the above procedure most effective. But it is essential that the beginning of the lens movement shall be slow and gradual.

A little soft cortex may be stripped off the back of the lens by the undepressed scleral lip of the wound, but lens matter left lying thus near the wound is comparatively easily dislodged afterwards. Cortex left below has always appeared to me particularly difficult to move. It is farthest away from the influence of the stream from the irrigator, unless the nozzle be introduced to a dangerous distance within the anterior chamber. And it is less responsive to pressure applied upon the eye than lens substance which has already been more or less displaced from its original bed.

The earlier operators delivered the lens by finger pressure through the lids. With the lower section spontaneous delivery was not uncommon when the patient looked upwards. Assistance was given by pressure below the wound through the lower lid, and light counter-pressure above. The direct utilization of the sense of touch is an advantage which is lost in instrumental expression. But the great objection to this use of the lids is that in unexpected movements of the eye the margin of the open wound is liable to sweep along the lid surfaces and borders, and thus possibly to become fouled by material containing pathogenic organisms. Contact with the lid borders is especially to be feared. Not only are they insusceptible of complete sterilization, but they may become more or less coated with Meibomian secretion, squeezed out by the pressure of the fingers upon the lid. Many well known surgeons still employ pressure through the border of the lower lid to express the lens. The upper lid is elevated by retractor or by the finger, and counter-pressure above generally by spatula or spoon. With an upper section there is not so much risk of direct soiling of the wound by the lid borders as with the lower section. But the danger incurred of vitreous expulsion by contraction of the lower lid upon the globe seems needlessly great. Trousseau presses out the lens by the back of the blade of the Graefe's knife, occasionally aided by counter-pressure applied by the edge of the upper lid.

Von Graefe tried various manœuvres to expel the lens through his comparatively narrow wound. At one time he attempted

to draw the lens upwards by movements of the spoon over the sclerotic from each end of the section. He also utilized the downward pull of fixation forceps, spoon pressure at the lower corneal margin, and upward strokes over the corneal surface.

In the delivery of the lens two chief points are to be borne in mind: firstly, to expel the lens as nearly as possible whole, in one mass; and secondly, and much more important, to ever avoid rupture of suspensory ligament, by too heavy or improperly applied force. It cannot be too strongly insisted upon that pressure and manipulation for the delivery of lens or of cortical remains need never be other than very gentle, if properly directed, and if the sources of difficulty are sought out. Heavier pressure is much more likely to rupture the zonule or posterior capsule than to move lens matter which has resisted lighter efforts. Very slow early movement of the lens is not always a sufficient guarantee that unsafe force is not being used, though, on the other hand, rapid early movement may be generally accepted as evidence of the employment of unnecessarily great, and therefore dangerous, pressure. While the exercise of patience and restraint is vastly important, it cannot be held that any great display of skill or dexterity is needed.

There are other *occasional difficulties* in the delivery of the lens in addition to those already mentioned, viz., displacement of the lens upwards or to the side, and adhesion of the conjunctival flap and wound margins by means of blood-clot. They occur thus:

1. There may be trouble from *too small a section.* This can only happen with a badly cut section, the incision at the deep surface of the cornea being much smaller than at the external surface, or from the use of a short flap in extracting a lens with large hard nucleus. One may be

tempted to employ rather heavy pressure, and so cause loss of vitreous. For the enlargement of the wound Stevens' curved tenotomy scissors are well suited. I think it is easier to cut with scissors than with a blunt-ended 'secondary' knife. Melville Black (Denver) uses a probe-pointed Graefe's knife.

2. The *capsule* may be *intact or insufficiently opened.*

(*a*) One is naturally alive to this possibility when one has used the cystitome with its point buried in blood-clot. The lens is found to move readily, but to a very limited extent, whenever pressure is placed upon the eye. It then stops dead. A second use of the cystitome generally puts matters right.

(*b*) In *Morgagnian* cataracts the making of a mere puncture, insufficient even for the passage of the smallest nucleus, is to be frequently expected, especially with the more opaque (dotted) capsules. Any trouble in expelling the nucleus of such a lens may unerringly be attributed to this source. Persistent cautious attempts at expulsion are usually successful in enlarging the aperture sufficiently after a time. But it is a tedious process, and at the end one finds often that the capsule has been more or less displaced upwards, though whether the tearing of the suspensory ligament which this reveals has occurred more particularly during the capsulotomy or during the expression may remain a matter of conjecture. If the capsule has been so much displaced as to lie folded close to the wound, and possibly in all cases when displacement can be made out—*i.e.*, when the lower limit of the capsule can be seen—its removal with iris forceps at the close of the operation is indicated, lest the dangerous complication, incarceration of capsule in the wound, should follow. Occasionally the enlargement of the capsular opening under pressure does not take place, and the nucleus is found to

come out enveloped in the capsule. In any case the mode of expulsion of the nucleus of a Morgagnian cataract is quite different from that of a complete lens. It is *pushed upwards* by repeated light strokes with the convexity of the hook applied to the cornea below it. The strokes being directed against the lower margin of the nucleus, the latter readily slides upwards as far as the enclosing capsule permits. When its upper margin has arrived close to the wound the upper lip of the incision is depressed with the fixation forceps, or preferably with spoon or loop, to guide the presenting edge of the nucleus forward. But the pressure applied with either instrument, above or below, must be very moderate. And as soon as the nucleus is found to be held rather firmly by tough capsule, the precaution is taken of substituting Desmarres' retractor for the stop-speculum. A second attempt with the cystitome introduced from the side, to widen the capsular opening,* may succeed in this, or may assist in intracapsular delivery by tearing the zonule below.

The same pushing strokes are needed for the expulsion of overripe cataracts, formerly Morgagnian, consisting of nucleus and capsule only. Here, as already stated, if the capsule be transparent, one has no means of judging whether the capsulotomy has failed completely or not, except by results.

(*c*) One must expect a little trouble with *very opaque capsules*, presenting the large dense *anterior plaque*. But if the opening has been made with a sharp instrument,

* Care must be taken that the nucleus is behind the point of the cystitome guarding the posterior capsule. In one case I punctured the posterior capsule in an attempt to widen the opening, and, the patient being nervous and unable to keep his eye turned down, I preferred to leave matters as they were rather than to incur certain loss of vitreous in the expulsion of the nucleus. The latter had become displaced laterally, so that there was a sufficient aperture for vision.

and enlarged if necessary by tearing, the shrunken lens may be expected to come through piecemeal. The expression may be tedious, since the capsule as a whole may be too tough for the opening to stretch or enlarge easily. Yet less pressure is required than would have been needed for intracapsular expulsion, as is shown by the preservation of the zonule intact. There is generally a broad equatorial rim of firm cortex which may need to be washed out in sections.

Should the zonule have been torn below by pull by cystitome or forceps on the dense anterior capsule—as shown by slight displacement of the shrunken lens upwards—the capsule lying in the wound serves as a guide to the lens and a support to the vitreous, preventing disturbance of the latter under moderate pressure. The capsule may be dealt with afterwards (see Chapter IV).

(*d*) There are more puzzling cases in which difficulty is experienced with the capsule though the cataract is not overripe. The source of the trouble is therefore not readily recognized. Some of our difficulties have been due to the making of an insufficient opening by a blunted cystitome (damaged by numerous heatings in the flame). In other cases the capsule has been seen afterwards to be very slightly opaque, though this was not clearly recognizable while the lens was in place, and the trouble was therefore probably due to rigidity of the capsule. Soft cortex may come forward freely through the opening, yet the bulk of the lens is persistently held back. Or if the cortex be firmer, continued pressure on the globe may force the margin of the lens upwards a trifle more at one point than elsewhere—*i.e.*, at the site of the partly opened slit in the capsule. Finally, if the cystitome be not again introduced, and if the attempts at expulsion be continued,

the capsule suddenly gives way, and the lens slips upwards through the wound.

3. Firm coherent lenses are naturally less easy of expression than those with soft and diffluent cortex, though they are more likely to come out whole or nearly so. *Thin discoid lenses*, especially the smaller ones, are sometimes singularly, and somewhat unaccountably, irresponsive to pressure put upon the eye. Care must be taken to avoid making the sclero-corneal incision gape unnecessarily. The sharp and thin upper margin of the lens may be seen tilting forwards with the cornea, and one fears for the stretched zonule* presenting in the wound. A second insertion of the cystitome to widen the capsular opening does not mend matters. The smaller lenses must be patiently worked upwards by light, jerky strokes with the convexity of the hook or spoon over the lower part of the cornea. And it is an advantage to keep the wound a little opened at the same time, either by means of the conjunctival flap gripped by the fixation forceps, or by a downward pull on the conjunctiva below the cornea. Larger lenses of the same type begin to move upward slowly under continued steady pressure on both sides at the lower edge of the cornea.

4. Difficulty and danger may arise from *early rupture of zonule*. The cases are at once divisible into two main groups according as vitreous has, or has not, come forward in front of the lens.

(*a*) Where the lens has not sunk backwards into the

* In simple extraction of these lenses there appears to be less risk of rupturing the zonule. Owing to the support of the iris, one appears to be able to tilt forward the cornea to any extent with impunity. I think that the marked difference in the proportion of vitreous losses experienced by some operators (*e.g.*, Drake Brockman ; see Chapter IV) in combined and in simple extraction, must have been chiefly in operating upon these lenses with firm cortex and thinned equatorial portions.

vitreous, there is frequently a fair chance of finishing without vitreous accident, or without increasing the vitreous loss should some already have been lost. The tear in the zonule may be either below or above the lens.

Rupture *below* the lens is much the least likely to give trouble. There is a tendency to slight displacement of the lens upwards, rendering depression of the upper margin of the wound imperative before expulsion is attempted. And if particular care be not taken, vitreous may follow the lens into the wound. But other cases of slight rupture occur, perhaps from the pull of the cystitome, without one being made aware of the fact, till focal illumination reveals it at the time of discharge of the patient.

Rarely the pressure or pull of the knife in completing the section may have been such as to rupture the suspensory ligament *above*. The lens may have been seen to slip more or less downwards. If vitreous tends to protrude only when pressure is put upon the eye, none having yet been lost, and if the displacement of the lens is quite small or inappreciable, capsulotomy may still be carefully performed and ordinary expression aimed at, because the only alternative—vectis extraction of the lens in its capsule—is certain to lead to considerable loss of vitreous, since the lens does not come easily, being held below. On other rare occasions the rupture may have been due to some sudden accidental pressure of speculum or other instrument upon the globe, or through spasm of the orbicularis, or otherwise. A little vitreous may have been forced out of the wound, and yet the lips of the wound may have come together again. The eye may be 'slack,' and there may be no apparent tendency to further loss of the humour. The same practice may be followed here. The scleral lip of the wound must be well depressed with

spoon or loop, which is ready to be slipped in behind the lens in case of necessity. The objection to the capsulotomy in these cases is that cortex is apt to be left behind. Little or no attempt can be made to extract this after the bulk of the lens has been expelled. Hence the practice is limited to fully ripe cataracts, in which trouble with cortex is least to be anticipated.

In cases where the wound is distinctly occupied by a prolapse of vitreous, broad or narrow, the spoon or loop must be at once inserted into the globe. The introduction of the instrument is always done in fear and trembling. Some degree of downwards rotation of the globe (variable according to the prominence of the eye) is essential, and one is placed in an almost hopeless position if the patient cannot maintain this position of the eyeball with some steadiness, since fixation by forceps is now quite out of the question. (Possibly further instillation of cocain may enable a troublesome patient to keep his eye more fixed.) The speculum is retained if the lids show not the least tendency to contract; otherwise Desmarres' retractor and finger depression are substituted. The spoon, held in the left hand, is first insinuated only behind the upper half of the lens to serve as a guide and support. Pressure is then cautiously applied with the hook or tortoiseshell spoon about the lower margin of the cornea in the usual way, and the lens thus delivered between the two instruments. But should the lens not come readily thus, and vitreous be escaping, the spoon must be passed down as far as the lower margin of the lens, to get a purchase upon it and to draw it upwards, pressing it against the cornea. Even so assistance may sometimes be afforded by light pressure with the additional instrument in front of the cornea.

(*b*) In other cases the lens is obviously displaced more

or less backwards, embedded in vitreous. In India this dislocation may be the previous work of a *vaid* or *hakim*. Or possibly, in a diseased eye, the depression may have taken place during the section cutting. We have here the lens in its capsule to deal with. In still other cases the faulty position may be due to ill-advised pressure with the cystitome, or to accidental displacement by the same or other instrument in a restless eye. And the capsulotomy having been performed, cortical matter may possibly have escaped out of the capsule, mixing with the surrounding vitreous, where it must usually be left. It may prove difficult to pass the loop over the upper edge of the lens. Preliminary depression of the upper wound margin by the instrument must be tried. It may still serve to direct the lens margin into the wound, and to enable the spoon to slip in behind it. If it fails, the loop must be directed within the wound, at first directly backwards.

The attempt may displace the lens bodily downwards and backwards, to lie loosely in the vitreous humour. In such a case it is recommended to remove the speculum and to wait until the lens comes up again into the pupillary area, and then to extract it with the loop. This reposition may take place within half an hour, or not for some weeks, if at all, necessitating in some cases reopening of the closed wound or the making of a fresh incision.* I have preferred to follow and remove the lens, even though vitreous were escaping through the open wound.† In other cases the spoon or loop presses the upper margin only of the lens backwards, causing the lens to rotate on its horizontal

* Hoor, *Zeitsch. f. pr. A.*, 1900, p. 19.

† Twice I have lost the lens in the vitreous permanently—once in a child and once in an adult. In the case of the adult the nucleus of the lens only was thus lost, and the patient went out of hospital with fair vision, after a 'needling' of a thin inflammatory pupillary membrane.

axis, the lower margin coming forward and upward to present in the wound.

5. One must expect considerable trouble at times simply from the patient's stock of self-command having become exhausted for the time being. One can get the lens margin to present in the wound fairly easily, whatever be the position and the degree of steadiness of the globe. And in most cases it is not difficult to get the lens or its nucleus sufficiently delivered to be seized and lifted out by the fixation forceps, even though the eye be directed somewhat upward. But with an eyeball swinging rapidly upwards at intervals there is danger of the open wound sweeping along an imperfectly sterilized upper palpebral surface. Also one fears lest the margin of the half-delivered lens be caught against the lid surface and bent forwards and downwards, carrying the corneal flap forcibly down with it. I have, however, never yet seen accident caused thus. It may be necessary to remove the speculum for a couple of minutes or so, and to instil cocain to enable the patient to regain some self-control. Afterwards as little is said as possible to him, and one must be prepared to express the lens with the eye perhaps turned a little upwards. Fixation with forceps may help a little to restrain upward movement, and also may assist directly in the expulsion of the lens.

The delivery of a cataract is thus in the great majority of cases by expulsion or expression. The comparatively rare extraction or withdrawal by means of sharp hook or forceps, or spoon or wire loop, is practised where opaque capsule needs removal, or where expulsion is inapplicable on account of, or from fear of, rupture of the zonule.

In von Graefe's earlier modified linear operations the exit of the lens through the narrow wound had to be assisted by

traction with sharp hook in about two-thirds of the cases—*i.e.*, whenever there was a hard nucleus of some size.

It is more particularly during this stage of the operation and afterwards that one may be troubled by undesirable evidences either of *excessive* or of *deficient tension* in the eye. On the one hand there may be an alarming tendency to expulsion of the contents of the globe, or, on the other hand, falling back of the cornea to occupy the space resulting from the loss of the lens and of aqueous humour, or more rarely some collapse of the globe as a whole. The two conditions seldom bear any relation to the tension of the eye as tested clinically before operation. The eyes which become slack during operation may even feel harder than normal beforehand, owing to senile rigidity of the sclerotic. And, according to my experience, the 'vitreous tension' observable after the eye has been opened may be absent in glaucomatous eyes. Certainly very marked examples of it are seen in eyes apparently normal except for the cataract present.

Though well marked cases of *vitreous tension* are decidedly uncommon, minor grades of the tendency are fairly frequently met with. The patients are usually comparatively young—perhaps forty or forty-five years old—and stouter in physique than the average. Their eyelids are sometimes noticeably tense, so that one cannot raise them well from the globe by the speculum, and the eyeballs are often somewhat prominent. The anterior chamber is frequently shallow, and the lens usually contains soft, flocculent, cortex. But the indications are neither sufficiently constant nor sufficiently characteristic to enable one to recognize the eyes beforehand. However, the conditions responsible for this vitreous tension being bilateral, one is able after operation upon one eye to anticipate it in the fellow eye.

As the section nears completion the lens and iris are pressed forward against the cornea, precluding the admission of any blood into the anterior chamber. As soon as the capsule has been opened, the lens, or the greater part of it, tends to slip upward, presenting in the wound. The lens may then slowly rise and make its exit spontaneously. Or a mere touch with an instrument on the lower part of the cornea, or a slight forward pull on the conjunctival flap is sufficient to deliver the lens. Afterwards the section may remain pressed a little open, and iris is apt to be incarcerated at each end, and to resist the feeble attempts at replacement which one may feel justified in making. Hence possibly permanent defects—considerable astigmatism, and all the possibilities associated with prolapse or incarceration of iris. And if the cataract is at all unripe, much cortex may have to be left behind, since the usual measures comprised in the 'toilet' of the eye are applicable to only a very limited extent. The speculum is maintained most carefully elevated, and the eye kept as quiet as possible, and the operation finished quickly for fear of rupture of the suspensory ligament. Such eyes are supremely unfitted for intracapsular extraction of the lens. Any opening in the posterior capsule or zonule must lead to a considerable loss of vitreous. And ordinary simple extraction is obviously inapplicable. The iridectomy should be larger than usual.

More or less evidence of the opposite condition—*slackness* of the eye—is more common. It is seen more particularly in the older patients. A considerable proportion of them are emaciated, with sunken eyeballs and lax lids. Blood and irrigating fluid tend to accumulate in the anterior chamber until expelled by external pressure. There may or may not be marked rigidity of the sclerotic. In the former case the cornea falls back into a deep cup

as soon as the body of the lens has been expressed, and this persists after removal of the speculum. In the latter case the cupping is less deep, and there may be some infolding of the inelastic sclerotic. These conditions may perhaps be seen only while the speculum is elevated. Should the latter be released, the weight of the instrument and of the lids may restore the globular shape of the eye. Where the sclerotic is quite rigid, the removal of cortical remains by external pressure is impossible unless the scleral lip of the wound is well depressed. The lens matter may, however, be washed out and the cornea refloated by a stream of fluid from the irrigator. These slack eyes are well suited for intracapsular extraction, because there is no tendency to loss of vitreous except by external pressure. They are also well suited for simple extraction, since prolapse of iris is unlikely to occur.

I have only seen one case of the rare extreme collapse of the globe, of which isolated reports have been published.

The lens was overripe, consisting of nucleus and capsule only, not tremulous. As it did not come easily, the zonule was purposely torn by pulling on the lens with a blunt cystitome. The collapse of the eye came on gradually, but there was no evidence of escape of vitreous. The lens had to be delivered by loop within the eye and pressure outside. Finally, the sclerotic was much folded and the corneal lip of the wound overlapped the scleral lip considerably.

The explanation of these conditions is largely conjectural. Variations from the normal elasticity and firmness of the sclerotic, and in the position of the globe as affected by increase or absorption of orbital fat, influencing the tension of the recti muscles, are obvious explanatory suggestions. Possible spasm of the tensor choroideæ, suggested by Nicati as a cause of spontaneous expulsion of vitreous, may be mentioned in connexion with vitreous tension.

Corneal collapse is said to be predisposed to by over-free instillation of cocain. The gradual onset of the state of collapse of the globe in the case just related appeared to show drainage from an extraordinarily fluid vitreous. The condition predicates an atrophy of the vitreous, and possibly also an atrophic zonule (Czermak). Chodin,* who published two cases, thought the sclerotic might have been of extraordinary tenuity, and without elasticity.

All operators of any considerable experience must at times have been relieved of the necessity of delivering the lens, by its accomplishment through spasm of the orbicularis forcing the arms of the speculum or the retro-tarsal portions of the lids on to the globe. According to the stage at which this occurs one may be relieved also of the necessity of iridectomy, and of capsulotomy. Rarely the lens alone may escape unaccompanied by vitreous. The somewhat bulky list of troubles and difficulties above detailed might well incline one to the endeavour to simplify matters by delivery of the lens in its capsule. But many of the troubles described are only rarely encountered. And due recognition of the difficulties ensures that few of them need prove insurmountable, or even grave.

TOILET OF THE EYE.

The procedures embraced by this term are to be considered in three subdivisions: I, the removal of lenticular cortex, blood, and free iris pigment from within the globe; II, the replacement of iris and of capsule and the adjustment of the wound surfaces, free from entanglements; and III, the cleansing of the conjunctiva and of the lid borders.

* *Westnik Ophth.*, xi (1894), 78.

I. Such blood-clot as may have escaped expulsion with the lens will be found to be held by adhesions to lens capsule or to iris. Some of it may come away with the lens cortex, but often it has to be left to become absorbed, and it may render the removal of cortex more difficult. Any small quantity of aqueous now accumulating in the anterior chamber (in slack eyes) usually appears muddy from admixture of traces of blood and of iris pigment. It may be expressed through the wound by the curette or lens expressor. Its expulsion serves to wash out the chamber a little, and may be facilitated by depressing the scleral lip of the wound. Any bright fluid flood present in the chamber naturally demands expression or washing away. But should the chamber refill at once from bleeding vessels covered by conjunctival flap, repeated expression is useless, and the blood must be left for absorption. In a few eyes there is to be seen a considerable quantity of dust-like pigment, rubbed off the back of the iris by the pressure and friction of the escaping lens. It seems better to wash out these minute particles, lest they should aid in the lodgment and growth of any micro-organisms which may gain an entrance.

An air-bubble may also need expulsion from the anterior chamber by pressure or by the douche. A little air is liable to be sucked in through the wound at times, when the latter is opened by the introduction of instruments, especially, perhaps, in eyes with collapsed cornea. If its removal proves troublesome it may be left to become absorbed.

But our chief concern is with any cortical matter which remains after the expulsion of the bulk of the lens. In few instances of ordinary cataract extraction are the contents of the lens capsule expelled absolutely in one mass. Even where the cortex is abnormally firm and not

readily separable from the nucleus, equatorial fragments are not infrequently broken off and left behind. Where the cortical layers are softened and broken up large amounts may be left behind, so much so that occasionally in a faulty operation the nucleus slips out alone. Even in Morgagnian cataracts, in the occasional examples when the fluid is slightly creamy in consistence, some of this most irritating fluid may need removal from behind the iris. In operating upon distinctly unripe cataracts with superficial layers scarcely changed at all from the normal transparency, unless great care has been taken to secure initial dislodgment from the lower periphery, very much sticky substance may remain. Its exact limits will not be clearly recognizable till the following day, when, by clouding, it will have become readily visible, and by rapid swelling it may have expanded to fill up the whole of the pupillary area and coloboma.

The Removal of Cortex.—Lens remnants may be displaced either—(1) by expression, or (2) directly with curette or spoon, or (3) by irrigation. Should the first method—the least objectionable—prove very inadequate, it may have to be supplemented by one of the others.

(1) Ripe cortex, whether firm or flocculent, may often be removed fairly completely after the delivery of the bulk of the lens by external pressure. And even unripe, and therefore somewhat sticky, material may be got away fairly well if it has already been a little displaced from its original bed during the expulsion of the lens. Those who deliver the lens by digital pressure through the lower lid naturally utilize the same means to express the cortical remains; and many who use instrumental pressure for the body of the lens prefer to remove the speculum and practice the 'lid manœuvre,' for the remaining cortex. In the time-honoured 'milking' movements, the finger is

applied with light pressure over the closed lids. Rotatory and radial movements over the cornea collect the lens matter from the periphery towards the pupil. And the border of the lower lid is utilized to push the cortex up through the wound, the upper lid being drawn up from the globe.

The same objection applies to this use of the lower lid on the score of infective risk, as in expulsion of the lens. Czermak used direct pressure upon the cornea with his forefinger clothed in a sterilized closely fitting rubber covering.

I have preferred always to continue with the same instrumental pressure and movements as in delivering the lens. Repeated light, quick strokes upon the cornea with the convexity of spoon or curette or hook are commonly effective in moving the underlying cortex. The passage of the material out of the eye is facilitated by depression of the posterior lip of the wound. This is particularly necessary in eyes with cupped cornea. In such eyes, with the sclerotic pressed well back by a curette, there is no especial difficulty in expelling lenticular debris, whereas without this counter-pressure above nothing is in the least effective but irrigation. Persistent efforts to express refractory cortex are inadvisable because the zonule or posterior capsule easily gives way, and because of the continued slight bruising of the iris, rubbing off its posterior layer of pigment cells and doubtless rendering its tissue more vulnerable to the attacks of micro-organisms.

(2) It is a fairly common practice to withdraw a particle or two of lens substance from the neighbourhood of the wound by the introduction of the curette. But all unnecessary insertion of instruments for this purpose is to be deprecated. There is the minor risk of puncturing the

zonule or capsule, and the much graver danger of carrying in infection from the conjunctival surface.

(3) *Irrigation* of the chambers and of the capsular sac may be decided upon as advisable or necessary for the final removal of cortex, blood, or iris pigment. But it is well always first to dislodge peripheral fragments by light, intermittent, jerky pressure with spoon or hook over the corresponding portions of the corneal circumference and neighbouring sclerotic.

(*a*) *By Siphon-Douche.*—The flask is held at an elevation of rather less than a foot above the eye. The tube of the irrigator, taken from the attendant, is grasped between the finger and thumb close to the nozzle, and a stream of fluid directed on to the globe and into the lower fornix to cleanse these surfaces as thoroughly as possible. If the eyeball be at all sunken, and still more if the palpebral aperture be shortened from old trachoma, the lids, elevated by the speculum, form a deep cup in which the irrigating fluid collects, covering the globe. The pool of fluid may be drained away by tilting the head well to the side, and by the assistant allowing the speculum to fall back upon the eye. But more than momentary release of the speculum is not permissible except in the case of reliable patients. And there are eyes so sunken that, even with the speculum unsupported and the head moderately tilted, the wound cannot be kept above the level of the fluid which collects in the conjunctival sac whenever the stream is allowed to enter.*

In such eyes irrigation should be avoided altogether unless the healthiness of the conjunctiva is undoubted. For if the irrigator nozzle be inserted into a wound thus

* This covering of the wound by the fluid accumulating in the conjunctival sac is impossible to avoid in most eyes if a downward section be made. This constitutes a minor objection to the lower section.

covered with fluid, the ingoing stream (unless, possibly, if the end of the nozzle be passed far within the chamber) must suck in also a current of fluid from the conjunctival sac. The risk of thus drawing in micro-organisms is very obvious, though it may be urged that immediately after a thorough douching there can be extremely few surface organisms remaining so loosely attached as to be possibly carried by a feeble current into the eye. A very

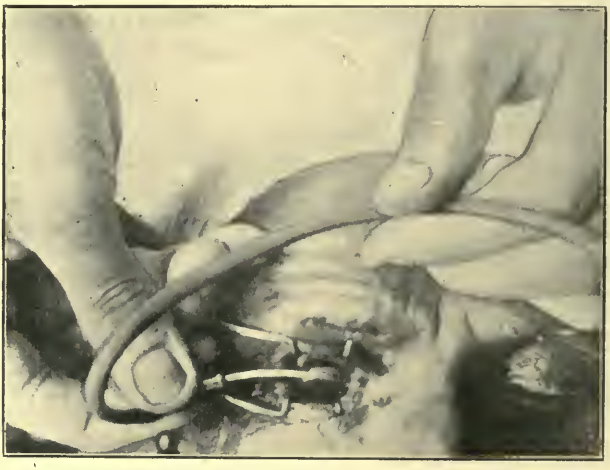

Fig. 69. —Irrigation of the Anterior Chamber.

free use of the douche should be confined to eyes with conjunctivæ presumably free from pathogenic organisms, and in which there is no difficulty in keeping the wound above the level of the conjunctival pool of fluid.

The tip of the nozzle being then brought quite close to the wound, a little above it, the stream from it may often be thrown into the chamber, especially if the conjunctival flap be lying turned down over the cornea. This may suffice to float up through the incision some or all of the cortex still remaining in the eye. But usually the extreme

end of the nozzle has to be inserted at one angle of the wound (see Fig. 69), its direction being transverse or oblique, and fixation of the globe being commonly dispensed with. And the stream is directed on to any particles of lens matter within range. The same may need to be repeated, possibly, at the other end of the section. Refractory peripheral fragments may perhaps be made to move by allowing the current to play all round them. Should the douche prove ineffective, it is stopped temporarily while light, jerky external pressure is again applied at the corneal margin, especially in the position corresponding with the refractory piece of cortex. Once the movement inwards from the periphery has been thus begun, the douche readily obtains a purchase upon the dislodged particle.

In perfectly steady eyes the tip of the nozzle may be passed far into the globe, behind the iris if necessary, even below. Bringing the mouth of the tube thus quite close to a piece of cortex undoubtedly enhances considerably the effect of the stream upon it. And the force of the current may be momentarily increased by the attendant raising the flask to a height of rather more than a foot above the eye. But it is rarely necessary to point the nozzle directly downwards within the chamber. When this is done, it is well for the assistant to bring the fixation forceps into use again, to restrain any possible upward movement of the globe likely to thrust the cannula through the posterior capsule. It is, on the whole, preferable to leave a little lens matter in the eye rather than to introduce the nozzle repeatedly far within the chamber, and rather than to irrigate very freely.

A fragment of lens substance may defy efforts at removal through having become attached to the iris by a thread of blood-clot, though otherwise free and movable.

Another temporary annoyance is that particles are occasionally whirled repeatedly around in the chamber instead of coming up through the wound. The nozzle may sometimes be of service, with the stream stopped for the moment, to sweep up particles of firm cortex lying fairly near the wound, whether adherent to blood-clot or not. Small bits are occasionally driven down between the iris and cornea into the lower periphery. They may even have to be left there, more or less adherent to the iris.

The 'milk' of ordinary Morgagnian cataracts is easily washed away. Elliot, of Madras, also washes the nucleus out from the eye. But at times the fluid part of the cataractous lens is of somewhat creamy consistence. And (especially in simple extraction) there may be some little trouble in evacuating the posterior chamber completely, without passing the nozzle of the irrigator behind the iris. Alternations of douching with external pressure over different portions of the corneal margin is indicated. We had two cases of inflammatory glaucoma set up by some of this irritating material left behind the iris.

I have always expelled any trace of fluid remaining in the anterior chamber after irrigation by passing the curette or tortoiseshell spoon upwards over the cornea. Prolonged contact of the ocular tissues with a fluid differing in composition from normal aqueous, and perhaps at a somewhat low temperature, appears undesirable. And there are always doubts as to the possible presence of conjunctival micro-organisms in the fluid.

(*b*) Of irrigation with a double-current syringe I have no experience. Surgeons who use this instrument claim that they avoid certain dangers and inconveniences associated with single-current douches. They hold that a forcible current from the latter is dangerous and productive of

pain lasting for some little time after operation ; and that the stream playing in the anterior chamber may hold back lens matter in the posterior chamber, and that when it is directed into the latter chamber it tends to propel the iris into the wound (in simple extraction). But these objections have very little weight. On the other hand, the general need for the insertion of the cannula of the double-action syringe far within the wound is a distinct drawback, and must lead to occasional accidents. The double syringe would appear to be much less likely than the ordinary douche to draw conjunctival organisms in through the wound. But to counterbalance this advantage, the narrow outflow cannula must prove quite an inadequate exit for many of the fragments of cortex which are commonly washed out of the eye, and must at times get choked.

II. The pillars of the coloboma are now pushed together by the curette* or iris repositor passed in horizontally at each angle of the wound. The coloboma, after the passage of the lens and cortical remnants, is rarely as narrow as it might be, and its inert pillars are often slightly folded. But it is very uncommon for any part of the iris to have been forced into the angles of the wound unless by vitreous (in vitreous tension or prolapse or escape). In this last instance comparatively little can be effected in the way of iris replacement. If vitreous is not actually escaping, further excision of iris may be possible at each side to free the wound. Nothing can be attempted in any case where the patient has quite lost control over his eye movements, and cannot keep the globe steady. The

* Now often taken up for the first time, and therefore, after the rather long exposure upon the instrument rack, rinsed before use with salt solution from the irrigator.

horizontal direction of the instrument is important,* and all tendency to elaboration in procedure inadvisable. A mere touch or two with the point of the spatula or curette upon the iris at either side usually suffices to obliterate its folds, and to narrow the coloboma sufficiently. If there is at all a complete conjunctival flap some lateral movement of the intrument may be required for its insertion under the flap. For horizontal insertion at the nasal end of the wound the spatula or curette should be more or less curved. Even so some outward rotation of the globe is usually necessary, the patient being made to follow with his eyes the necessary movement of his hand, directed by the assistant.

We have found that with the narrow iridectomy which we have always made, this replacement of the iris is quite effective also in reducing possible entanglements of capsule from the wound. We have not found any special attention to the capsule necessary if the pillars of the coloboma be approximated as well as they can be. Some operators, especially in simple extraction, prefer to replace iris and capsule, particularly when prolapsed, with the stream from the irrigator. Should these means fail, it is recommended to seize the pillars of the coloboma with iris forceps, and to draw them into position thus. Should the iris still not remain in place, the wound may be searched diligently with iris forceps, with the aid of focal-illumination, for points of capsule possibly lying in it. According to L. Müller† a tag of capsule may be fixed in an angle of

* The eye is thus safeguarded against accident, in case of sudden upward movement. The minute and accurate replacement of the displaced iris with a spatula directed vertically downwards within the chamber, as sometimes taught, is a measure adopted only for more reliable and steady patients than it has been my lot frequently to encounter.

† *Kl. Mbl. f. A.*, xl (1902), Bd. 1.

the wound, and may hold the iris fast there also. The spatula, in attempts to replace the iris, glides over the capsule instead of entering the fold of the iris.

Knapp, Förster, and Swanzy* have recommended the routine search for capsule lying between the lips of the wound. Iris forceps are passed into the incision and repeatedly opened and closed throughout its length. Any portion of capsule seized is slowly drawn out, to be either snipped off with scissors or torn away, with the assistance of a second pair of forceps if necessary. Swanzy found capsule in the wound thus in about 25 per cent. of his cases. Loss of vitreous need not be feared in the partial removal of capsule if the speculum be first removed. But it has been objected that in drawing out one portion of membrane one may pull another portion into the incision.

Should impacted capsule be keeping the iris also displaced, the release or removal of the entangled shred of capsule should enable the iris to be fully unfolded. Further excision of iris at this stage of the operation is to be avoided if possible. It is often difficult and dangerous (Chapter IV), and leaves a broad coloboma, unsightly, and with visual drawbacks. But it is vastly preferable to leaving iris to heal in the wound.

The old operators first attempted to reduce prolapsed or incarcerated iris by gentle massage of the cornea through the upper lid. Contraction of the sphincter may sometimes be excited by the friction.

Blood-clot lying about the wound adherent to sclerotic and episcleral tissue is removed with iris forceps or curette, or wiped away with a sterile moist swab.

The conjunctival flap is then carefully smoothed out by upward strokes over it with the point of the curette. Or, if the flap be very short, the point of the cystitome may

* 'Handbook of Diseases of the Eye,' 6th Edition, p. 373.

be better used for this stretching-out process, this instrument obtaining more purchase upon the membrane. The margins of the deep wound are thus closely approximated, except where the cornea is collapsed, preventing immediate close coaptation of the wound surfaces. In these cases adjustment of the wound surfaces may be expected to take place automatically when the chamber refills.

The speculum is now removed. The assistant gives up his hold of the instrument to the surgeon, who keeps it elevated with one hand, while he loosens the screw and presses the arms together with his other hand. The assistant then draws the lower lid away from the speculum and keeps it depressed until the upper arm is slipped from under the upper lid. Should Desmarres' retractor have replaced the stop speculum, the lower lid must be kept depressed until the retractor is removed.

III. In Bombay for many years it has been our almost invariable custom now, at the close of the operation, to pass the curette lightly over the whole palpebral conjunctival surface—*i.e.*, over the whole secretory portion of the mucous membrane—to remove mucus a second time. Sufficient time has elapsed since the cleansing immediately before operation for a further secretion of mucus to have occurred commonly in response to the perchloride stimulus. The curette used in this way often causes rather a sore feeling, and care must be taken not to occasion contraction of the orbicularis. I have never known any accident from this cleansing of the conjunctiva. To guard against it the lower lid has always been firmly depressed by the forefinger of the assistant, the finger lying flat upon the patient's cheek, to be out of the way of the curette. The lower lid in particular needs to be

controlled, because its pressure upon the eyeball would tend to lever the wound open, whereas spasm of the upper lid would tend rather to close the wound. Any mucus detached from the lower fornix and lower tarsal conjunctiva is washed away by a stream from the irrigator. The eyelashes of the upper lid are then seized by the left forefinger and thumb to raise the lid for the passage of the curette beneath it, the patient looking downwards

FIG. 70.—REMOVAL OF MUCUS WITH THE CURETTE.

(Fig. 70). The curve of the curette is forwards, so that the point of the instrument cannot enter the wound by any mischance. Two or three sweeps of the instrument in light contact with the stretched palpebral surface are sufficient to transfer most or all of the secretion to swabs held by the assistant.

This measure is a continuation of the cleansing practised immediately before operation, and is a supplement to the treatment with strong perchloride. There can be no doubt (see Chapter IV) that the mucus secreted thus early in our cases must have often contained pathogenic conjunctival organisms.

It seems reasonable, therefore, to remove it as fully as possible. Yet this removal, so far as I know, is exclusively a Bombay practice. Others who have used perchloride freely have not troubled about any supplementary cleansing, and have had good results. We cannot feel sure, therefore, whether this measure has in any degree served in its object of aiding to prevent infection of the wound. Possibly it has been mainly or entirely superfluous; yet it has been at least harmless. And since our figures in regard to infection have been quite exceptionally good, it may be that this simple precaution has contributed its mite towards the complete result. Though ordinarily microbes imprisoned in mucus may be unable to gain access to the wound, it may be quite otherwise when the lips of a purely corneal wound, uncovered by conjunctival flap, are not in good apposition.

Finally, sterile atropin drops may be instilled if much cortex or blood-clot has been left in the eye, or if the iris has been exceptionally mutilated, having perhaps shed a good deal of pigment; or if iritis is feared from the condition of the patient, as in advanced Bright's disease; or, finally, if there is any question of the possibility of infective organisms having been carried into the wound —*e.g.*, from the lid margins. Dilatation of the pupil may be secured now in cases where it will be unobtainable after twenty-four hours. Since any tendency to prolapse of iris is enhanced by the atropin, one would hesitate to use the drops in eyes with vitreous tension or when the edges of the wound were not in good apposition.

THE DRESSING.

The eyelids are closed gently by the surgeon. If the patient be told to close his eyes he is apt to do it much too vigorously. A pad of dry absorbent wool, either boric or simple sterilized wool, is applied on a few layers of gauze and fixed by a bandage. A shield is fixed over all.

Sterilized iodoform is applied about the inner canthus by some surgeons in cases where there has been lacrymal trouble. At one time in Bombay we applied it regularly over the cataract wound. It was doubtful whether it did much good, and very occasionally a little of it found its way into the anterior chamber.

Pagenstecher applies von Hoffmann's ichthyol dressing over the closed lids. Pure ichthyol is smeared over the lids and covered with gauze soaked in liquid paraffin. Absorbent wool is laid over this and kept in place by a wire shield in the form of spectacle frames. The ichthyol probably has some antiseptic action. Others have similarly employed boric and other ointments to prevent the drying of discharge upon the eyelashes, and to offer a mechanical obstacle to the entry of micro-organisms into the conjunctival sac.

The object of the ordinary dressing is to maintain the lids at rest and to protect the eye from light (and from dust ?), and to absorb watery fluid passing out from between the lids. It must exert little or no pressure upon the globe, and yet must not be liable to accidental displacement or easy of displacement by the patient. Haab says* of a too tightly applied dressing: "The pressure of such a dressing constantly reopens the wound, and the patient is very apt to try to overcome the unpleasant sense of pressure by closing the lid tightly, and thus makes matters worse. If the bandage is too tight, the tears are prevented from reaching the palpebral fissure, because the lids are pressed tightly together, and in this case, also, the patient adds injury by closing his eyes still more firmly. The tears collect under the lids, blepharospasm increases more and more, and finally there is severe pain, and, of course, injurious pressure upon the wound, and harmful retention of the secretions, both from the wound and from the conjunctiva." A displaced dressing not only fails in its object, but is likely to press unevenly upon the eye.

Though occlusion of both eyes is required for some days after vitreous accident, and for one day after simple extraction, it is not so much needed after the combined operation. In Bombay the other eye was simply covered by a loose strip of

* 'Operative Ophthalmology,' p. 48.

lint hanging from the brow,* where it was fixed by the bandage.

To guard against the application of possibly injurious pressure, the absorbent wool covering should be large enough to lie over all the bony prominences around the eye, and should be of the same thickness over them as over the lids; and the bandage must be broad. Many surgeons are careful to fill up the hollows around the eye to immobilize the lids. An ordinary surgical roller bandage, properly applied, affords reliable fixation. Firm fixation of a single 'occlusive dressing,' as distinguished from a 'pressure dressing,' is obtainable only by turns of the roller tightly drawn around the head and forehead, and not covering the eye. Two such turns are sufficient, passing above the ears, but rather low down behind the head. And if the bandage be broad, 2½ inches, only a single turn below the ear and over the eye is needed. This is not pulled tightly over the eye, but is drawn well up under the ear. And it is tested by inserting a finger under it to see that it does not lie loosely over the cheek. This single turn does not suffice, however, to prevent the patient from getting his finger under the dressing, as he is apt to do when awaking from sleep, if there be any itching of the lids from drying secretion. This is to be prevented by the shield. A 2-inch bandage lies more smoothly than a broader one, becoming less folded where it presses above and below the ear, but it does not distribute the pressure so well over the margins of the orbit.

The patient's head must lie passive, well supported by the assistant, during the application of the bandage.

The double bandage covering both eyes in a figure-of-8 is more easy to apply firmly without pressing upon the eye. For the turn below the occiput and below both ears cannot slip, and, with both eyes to be covered, the turns may pass less obliquely across the face, being drawn well in to the ears, above and below.

Except in very hot weather, the heat of the dressing is not irksome. In place of the roller bandage single strips of material—gauze, or knitted or webbed material, more or less elastic—are frequently employed. The ends are fixed by adhesive plaster or by tapes above and below the ears.

* Owing to the poor nursing arrangements, the patients used to find their way about the wards unassisted almost from the beginning.

Russell Murdoch's bandage, made of flannel, is one which we have used in Bombay with satisfaction.

Or simple strapping may be employed in narrow strips from the forehead down over the cheek. The use of long strips of strapping is unpleasant, especially if the eye has to be exposed more than once a day for the instillation of atropin; and short strips are liable to displacement.

A shield is required to protect the eye from injury by accidental pressure or by insertion of the patient's finger under the dressing. Among single models may be mentioned Fuchs' wire lattice-work screen, also the perforated aluminium and Lloyd Owen's cardboard 'Cartella' shells. Unless well fixed by strapping they are scarcely so firm as the double shields.

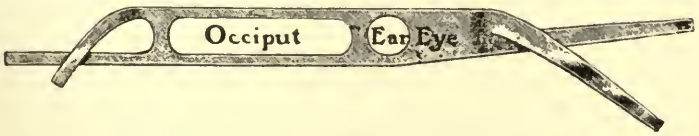

FIG. 71.—RUSSELL MURDOCH'S BANDAGE.

Among the latter may be mentioned Fuchs' double model and Bronner's wire shade (see Instrument Catalogues) as suitable for application over the dressing and for use after the dressing has been discarded.

Haab has used starched bandages.

AFTER-COURSE AND AFTER-TREATMENT.

The patient is carried to bed if the operation has been performed on a table. He must expect a little soreness o the eye for a few hours.

It is a usual custom to keep at least the one eye bandaged for four days or so in uncomplicated cases; occasionally longer, whenever the healing of the wound is delayed. But every day the coverings should be removed for inspection of the eye and for cleansing of the lids.

In our work the dressing was frequently found somewhat discoloured and stiffened after twenty-four hours, and perhaps

in part adherent to the skin of the lids or surrounding parts, having evidently been soaked more or less with watery fluid from the eye. There was some lid swelling from the perchloride treatment of the conjunctiva, which lasted for a few days at least. For the first few days the eyelashes and lid borders generally needed to be cleansed from mucus accumulated upon them, with bits of lint soaked in 1 in 5,000 perchloride. This mucoid discharge was frequently more scanty and more transient than that from the fellow eye, in which, perhaps, a chronic conjunctivitis had been aggravated by mere closure of the eye, without bandaging. It was not, therefore, attributable to the perchloride irrigation. At these daily cleansings the conjunctival sac was not washed out at all. Possibly a little of the lotion employed frequently found its way in between the lids, for we thought that when boric lotion was used for the washing, there were more cases of troublesome persistent conjunctivitis than when the 1 in 5,000 perchloride was employed. The cleansing must be done with care, and possible ill effects from spasm of the orbicularis avoided by keeping the lower lid pulled well away from the eyeball throughout. Pressure of the upper lid alone can do little harm, as it keeps the wound closed, but pressure of the lower lid alone would force the wound open.

In our cases there was generally at first some bulbar conjunctival injection as well as considerable ciliary injection. The former and much of the latter were attributed to the strong sublimate solution which had been employed. With us the ciliary congestion lasted about double the ordinary period, which is said to average eight to ten days for the redness at the sides and below the cornea, and fourteen days or more for the congestion localized about the wound. In some of our cases, however, there was practically no redness of the eye from beginning to end.

The patient is kept recumbent for twenty-four hours. He is directed not to lie on the operated side, and not to lie continuously upon his back, lest flatulent distension of the abdomen be set up. He may turn from his back to his side, and back again without help, but he should understand that frequent turning tends to loosen the bandage. He must be assisted in rising from the bed and in lying down for a few days. Very old people and chronic bronchitics may maintain the sitting or

semi-recumbent attitude from the beginning, if they are suitably propped up with pillows; or they may change their position repeatedly, provided they remain passive in the hands of the attendants who move them. A sleeping-draught must be given, if found necessary, for the first night. The patient may sit up in bed after twenty-four hours, but even after the combined operation it is perhaps well that he should not leave his bed for two or three days.

The bowels are not moved as a rule on the first day, having been sufficiently relieved by the laxative administered before operation. The patient must avoid straining at stool. Some people cannot pass urine into a receptacle while in the recumbent posture, and may have to be allowed out of bed for this purpose. Men with enlarged prostates are perhaps more liable to retention of urine if atropin is being instilled frequently after operation, and must be watched in this respect.

The patient must talk little, and must only take soft and fluid food, requiring no mastication, as long as the bandage is in use. Any tendency to coughing is restrained with morphia, etc.

The light in the room is kept rather dim. This is preferred to ordinary daylight by the patients, and is only reasonable where so many pass through at least the earlier stages of iritis, while the depressing mental influence of a very dark room is avoided.

Healing of the Wound.—Some of the results of histological research into the repair of corneal and sclero-corneal wounds in men and in animals need brief mention.

The usual section at the sclero-corneal junction, like purely corneal perforating wounds, gapes a little both superficially and deeply, from elastic retraction of Bowman's and Descemet's membranes. There is also a tendency for the corneal flap to become displaced a little forward and to overlap or override the scleral lip of the wound. The suggestions which have been put forward to explain this displacement include the pressure of the lids, the action of the extraocular muscles, the ocular tension, and the normal elasticity of the cornea released from tension.

The middle layers of the wound surfaces, swollen by imbibition of fluid, may come into direct apposition, or a narrow space between them may be bridged across by a plug of fibrinous lymph.

In either case retention of aqueous sufficient for the refilling of the anterior chamber commonly results within a few hours. The gaps, superficial and deep, between the wound surfaces fill up in the course of two or three days, or sometimes considerably longer,* by epithelial and endothelial ingrowth. When this is complete, the second stage of repair is accomplished. It is still only a temporary and provisional means of union, but much firmer than the earlier adhesion, and it is the only process of repair recognizable until after the usual period of the patient's stay in hospital. Permanent fibrous union between the corneal lamellæ on the two sides is a slow development occupying months. However this may be, closure of the wound is commonly continuous after the first few hours. It is only within twenty-four hours that evidence of reopening of the section after temporary closure is frequently met with, in the form of prolapse of iris, or very rarely of vitreous, or emptying of the anterior chamber after it has been refilled. Later than this the adhesion is apparently only liable to be broken down by some definite cause, such as sneezing or coughing, or pressure upon the eye.

Clinically, the gaping of the wound, superficial and general, may be recognized, and the edges of the wound may be slightly elevated from imbibition of aqueous and of tears. The fluid entering the tissues also accounts for a delicate early diffuse cloudiness spreading for a short distance from the wound, with a faint dulness of the surface. The cloudiness is exaggerated later for a time by cellular infiltration. The line of the wound remains permanently visible as a whitish scar.

Sclero-corneal incisions, though still mainly corneal, heal up somewhat differently. Early cohesion may take place in the same manner, but the surface epithelium is separated from the wound by subconjunctival tissue. And the second stage of repair is accomplished by downgrowth of this subconjunctival tissue. And where there is an extensive conjunctival flap covering the greater part of the section it may exercise a great influence upon the progress of healing. The flap adheres quite early to the underlying tissue by means of blood-clot and fibrin. The aqueous, being then retained by the elastic conjunctival covering, stretches and elevates the flap, and forces the sclero-corneal surfaces asunder. Temporary breaking down of the

* Thomson Henderson, *Oph. Rev.*, xxvi (1907), 127.

adhesion, re-emptying the chamber for a few days, is not very infrequent. If the conjunctival flap be fairly long as well as extensive, the gaping of the central portion of the underlying wound may be considerable—a millimetre or more across. Approximation of the surfaces may never be complete, and the permanent repair of the wound must then depend largely upon the episcleral tissue overlying and occupying the gap. A 'filtering cicatrix' results, allowing aqueous to pass through to the subconjunctival tissue in the neighbourhood, where it keeps up a permanent slight œdema.

Clinically, the early distension of the conjunctival flap is a striking feature. Through the conjunctiva the open sclero-corneal incision is seen. In some cases the fluid escaping under the conjunctiva diffuses widely, causing swelling of the bulbar conjunctiva at the sides and towards the lower fornix, and producing some slight fulness of the lids. This *filtration œdema* may be seen without marked elevation of the conjunctival flap. It is paler than inflammatory swelling, and is further distinguished by its gravitation to the more dependent situations, and by the absence of other evidences of inflammatory reaction. The two forms of swelling may, however, be combined.

This noticeable general filtration œdema subsides in a few days. The swelling of the conjunctival flap commonly lasts a few days longer. When it subsides, the separation of the deep incision may be considerably lessened. Speaking generally, gaping of the sclero-corneal section may be taken as evidence that the conjunctival flap is too large.

In the large majority of cases sufficient approximation of wound surfaces, with proliferation and condensation of subconjunctival tissue, has occurred to raise the tension of the eye to nearly normal at the usual time for the patient's dismissal from hospital. For this rise in tension complete approximation is by no means always necessary.

On the other hand, a small percentage of our cases were either kept back on account of low tension, or had to be sent away with the eye still quite soft. And these were not always eyes in which visible gaping of the deep wound persisted (see Chapter V).

A curious feature of the healing of the majority of our cataract wounds in natives of India was a subconjunctival *pigmentation* along the line of the cicatrix. It was sometimes scarcely noticeable, but in other instances very dark (Fig. 72). It was evidently due to migration of uveal pigment, for there was always the usual adhesion of

FIG. 72.—PIGMENTATION ALONG SCAR LINE.

the base of one or both pillars of the coloboma to the deep surface of the cicatrix, and with the denser colouring sometimes rather more extensive adhesion.

It was less frequent after simple extraction, owing to the more general freedom of the base of the iris from the scar. It occurred without actual inclusion of iris in the scar. The source of the pigment was shown clearly, also, by its tint. The minute particles of which the whole was composed appeared quite black, whereas the neighbouring conjunctival pigment was brown. The colouration was at its height two or three months after operation, and gradually subsided in the course of several succeeding months.

We had the opportunity of examining many eyes a few

years after our operations—up to nine years. Many of the operations had been performed with unnecessarily large conjunctival flaps. There were, consequently, many cicatrices certainly filtering, and many others doubtful in this respect.

The chief sign of filtration was œdema of the conjunctiva, extending for some distance from the scar, and recognizable by the abnormal size and depth of the pits produced by light touches with the point of a probe. The œdema was usually rather more marked about one portion of the scar line than elsewhere. It could often be increased by finger pressure upon the globe, applied for half a minute or more through the lower lid. The central portion of the cicatrix was visible as a broad uniformly grey line under the conjunctiva, tapering at either end. The lower limit of the scar was sometimes sharply defined by a line more intensely white than the neighbouring sclerotic, representing the margin of the sclero-corneal flap. There were no dark points in the scar suggestive of fistulæ, and no bulging or unevenness. The ocular tension was normal or only slightly subnormal, but could be reduced rapidly by pressure upon the eye.

At the first dressing, twenty-four hours or rather less after operation, the condition of the interior of the eye more urgently demands investigation than that of the wound. A careful examination of the pupillary area and coloboma and of the iris is made under focal illumination. The light of a candle or lamp, focussed with a pocket lens, is thrown upon the parts from the side, so that no direct rays can reach the fundus and excite reflex closure of the lids. It is only by such early examination that the necessary means can be taken to break down early adhesions between iris and capsule, to remove the iris from contact with iritating lens debris, and to control iritis, infective and otherwise. At least in our work, after the use of strong perchloride lotion, early dilatation of the

pupil was considered necessary or advisable in the large majority of cases—that is, in practically all cases in which the pupil did not react to the light thrown into the eye. And often the number of atropin instillations made during the first few days was limited only by the necessity of avoiding general symptoms (see Chapter V). It is a good plan to have the drops warmed to avoid causing reflex closure of the lids.

After the final removal of pad and bandage, the eye is still kept protected by the wire shield till the patient's discharge from hospital. Ten days after operation the eye is examined to see if the patient is fit for discharge, or requires a 'needling' for after-cataract. The needling is then performed if required, and the patient kept in for a day longer. Otherwise if the case has progressed favourably it is now practically at an end. The vision is tested with glasses, and the patient sent out wearing simple plane smoked glasses as long as any redness of the eye persists. Correcting lenses should not be used, as a rule, for a couple of months* after operation; this ensures that no writing or reading shall be attempted. A few of our cases were kept back if there were beds available—cases in which the tension was still very low, or in which there was some suspicion of slight iritis. And of course cases presenting definite complications had to be kept back.

On focal illumination adhesion of the base of one or both pillars of the coloboma to the back of the cornea at the line of incision can be made out in the large majority of cases. The capsule should be seen in a plane more posteriorly. Quite occasionally more extensive

* Most of our hospital patients were not seen again. They were provided with cheap spectacles, spherical lenses, but told not to wear them till the two months had expired.

adhesion of the base of the iris will be found, though the healing of the wound may have progressed uninterruptedly. Thereby more or less shallowing of the chamber above is produced, and tremor of the iris prevented. The iris, when free from adhesion both to the line of the wound and to the capsule, generally hangs so loosely that it is shaken by every movement of the eye.

A few simple directions to the patient are advisable on discharge, that he may refrain from stooping and from all powerful exertion. And it is well to keep all patients under observation, if possible, who are allowed to leave hospital with considerable ciliary injection, or with some slight traces of iritis.

Post-Operative Astigmatism.—In testing the vision at the time of discharge from hospital the proportion of patients requiring a convex cylindrical lens with axis horizontal or nearly so, in addition to the usual spherical lens, varies considerably with the method of operation practised, and with several factors as yet imperfectly studied. This astigmatism has been shown to be due not only to vertical flattening of the cornea, but also to an increase in the horizontal curvature.* In some cases the degree of astigmatism found a fortnight or so after operation persists unaltered, or even increased later. In others it either diminishes somewhat or entirely disappears in the course of a few months. Reduction in the amount of the corneal flattening may safely be ascribed to gradual adjustment of the wound surfaces, displaced by forward springing and overriding of the corneal flap. In sclero-corneal sections the downgrowth of episcleral tissue interposes a wedge between the wound surfaces, keeping them apart. Hence the permanent element in the abnormal curvature is commonly greater in sclero-corneal than in purely corneal incisions. The astigmatism from a corneal section is apt to be greater the nearer the section to the centre of the cornea. Jackson† found that in only 15 per cent. of cases was the permanent amount of astigmatism

* Treutler, *Zeit. f. A.*, June, 1900.

† *Oph. Review*, xii (1893), 349.

reached within two months, while in 20 per cent. regressive changes continued for more than three months.

Rollet,* reporting on 150 cases, found that in from two to five months after operation 25 per cent. of the corneas were free from asymmetry, while the remainder had a mean astigmatism of 2·57 D. A year or more after operation there was either complete disappearance of the astigmatism or the development of a small degree at right angles to the original.

Clark† (Columbus, Ohio) reports an interesting observation of a case in which increase of corneal curvature was due to a band of pupillary membrane, maintaining the convexity of one meridian of the cornea like the string of a bow. Division of the band reduced the curvature by 1·25 D. This observation suggests that a factor in the production of the early overriding of the corneal flap may be the vertical tension of the membranous diaphragm, composed of lens capsule and zonule, acting upon the posterior lip of the wound. The axis of the correcting lens is nearly always parallel to the base line of the section, but the astigmatism is sometimes irregular.

For some years I have taken such opportunities as have presented themselves in private practice of noting the degree and progress of the astigmatism in my own cases. The amount at the time of ordering spectacles, generally about two months after operation, has varied from *nil* to as much as seven dioptres. I have been struck by the small amount of change which has taken place after the first examination about a fortnight after operation. This has usually persisted with little appreciable alteration for years. The absence of any notable tendency to diminution of the astigmatism must be counted a definite drawback to the use of a large conjunctival flap. Still, compared with the question of the safety of the eye, abnormal corneal curvature is a very minor consideration. Some eyes with the larger degrees of astigmatism have with correction attained excellent central vision. And it has been remarked that it is to the general advantage of the patients to accept a low grade of average vision rather than to considerably improve the average visual results at the cost of a fractional percentage of total loss. In a few of our cases the

* *Rev. Générale d'Oph.*, Juin, 1904. Ref. *The Ophthalmoscope*, ii (1904), 523.

† *Ann. of Ophth.*, viii (1899), 504.

eyes examined months or years after the prescribing of glasses have shown even a slight increase in the degree of astigmatism. Our results show that progressive contraction of the sclero-corneal gap often formed under a large conjunctival flap is not to be anticipated. Cicatrization apparently takes place solely by the consolidation of the overlying tissue and by filling up of the gap by downgrowth of this tissue. (Possibly narrowing of the interspace might have been brought about by a pressure bandage, begun a week or so after operation.)

The *visual result* attained at the time of discharge from hospital is often comparatively poor in spite of a clear pupil (perhaps cleared by needling), and of correction of astigmatism, and there is steady improvement in the course of a few months. Some of the early defects may at times be ascribed to the fine lines on the posterior surface of the cornea described in Chapter V. Where the cataract has existed for a long time, as is often the case in India, there may be amblyopia from disuse. Moulton* recorded the progress of improvement in two marked cases of this amblyopia. In cases of congenital or infantile cataract operated upon in youth or early adult life the result is very poor. Some of our patients could only see moving bodies afterwards.

Coloured Vision.—Erythropsia is an occasional complaint of aphakic patients after exposure to bright light, especially, perhaps, in cases where a broad iridectomy has been made. We saw almost nothing of it in Bombay, probably because the wards were rather dark, and the patients were all supplied with cheap dark glasses and shades on dismissal. It is caused mainly by the ultra-violet rays, for which the lens has a high absorptive power.

Cyanopsia has been comparatively seldom recorded. This is possibly because it is a very transient condition. Elliot, in Madras, found that slightly more than half of his patients had blue vision for some period of their stay in hospital.† Enslin has also drawn attention to this affection after cataract extraction. Maddox suggests that as most cataractous nuclei have a yellowish or amber tint, the sudden removal of this coloured medium is sufficient to flood the retina with the complemental colour.

* *Oph. Record,* April, 1903.

† *The Ophthalmoscope*, iv (1906), 15.

CHAPTER III

EXPULSIVE HÆMORRHAGE. VITREOUS ACCIDENTS

In the foregoing pages numerous difficulties and accidents have been set forth, distributed according to the stage of the operation which they complicate. There are still two grave complications which belong to no particular step of the operation, and which may occur even later during the healing period. These complications, expulsive hæmorrhage and prolapse or loss of vitreous, are therefore to be considered now. The trouble with vitreous is generally a consequence of one of the mistakes or difficulties already dealt with.

EXPULSIVE HÆMORRHAGE.

By this term is understood bleeding from the fundus sufficient to expel part or the whole of the contents of the globe through the wound. It is also known as 'essential' and 'retrochoroidal' hæmorrhage. It is, fortunately, a rare accident. Formerly, in nearly 3,000 extractions I had only met with it twice, but now, with the total only about 5,000, I have to record seven typical and two incompletely expulsive cases. De Wecker reported eight hæmorrhages in 3,000 operations, Sattler * only four cases in over 3,000 operations.

The bleeding, also seen after iridectomy for glaucoma, has been shown by anatomical investigation to come from choroidal veins. The blood, collecting first between the sclerotic and the choroid, ruptures the latter. The accident most frequently occurs

* *A. f. O.*, xlvi (1898), 235.

during operation or immediately after it, but it may happen at any time during the first twenty-four hours after operation, and has been known as late as ten days afterwards.* In the first case the corneal flap is slowly pressed forward, vitreous presents in the wound and, after rupture of the zonule, escapes. Blood soon follows, and often after the expulsion of the whole or greater part of the vitreous, detached portions of retina and choroid may be seen. Occasionally, however, the appearance of blood in the wound is the first indication of trouble. When the hæmorrhage takes place later, we find the dressings soaked with blood, the lids pressed forward, and protruding from the widely gaping wound a large clot of blood. The eye filled with clot feels hard, and perception of light is lost. The onset may be marked by acute pain, or there may be merely a feeling of tension or heat, or no particular feeling of discomfort at all. There may be vomiting, and epileptic seizure has been recorded (Berry).

The bleeding sometimes stops early. At other times there may be continued or repeated oozing for days, in spite of a pressure bandage. The globe afterwards shrinks. In former times panophthalmitis sometimes developed.

In some cases disease of choroidal blood-vessels has been found—dilatation, degeneration, and infiltration of the walls of the veins, also sclerotic changes in the arteries. But in other eyes no evidences of disease have been found in the blood-vessels.

The accident is recognized as perhaps the chief danger in extracting the lens from a glaucomatous eye (one of our cases was thus accounted for). Venous congestion from vomiting, coughing, or straining has been blamed as a partial cause, also strong pressure upon the eye during operation. Noyes and da Gama Pinto reported the occurrence of the accident in highly myopic eyes, probably from disease of the choroid (see also our case mentioned in the footnote to p. 74). Hæmophilia was mentioned in one case by da Gama Pinto. Often no explanation of the complication can be found.† And possibly the old idea that the bleeding was a result of loss of vitreous may

* White Cooper, quoted by Terrien, 'Chirurgie de l'œil,' p. 172.

† Sattler thought that the accident was rarer in the old days before cocain was used. But it has been suggested that some of the cases were then reported differently, being attributed to vomiting due to the anæsthetic.

sometimes be partially correct.* In patients who have had both eyes operated upon the disaster has usually been observed only in one eye.

One very occasionally sees inexplicable escape of vitreous, apparently spontaneous, during operation—so suggestive of the onset of deep hæmorrhage. But no blood appears, and the eyes do perfectly well afterwards, and one may fail to find any choroidal detachment or other sign of fundus hæmorrhage. Possibly, however, the presence of after-cataract may at times account for this negative finding.

There are also rare cases of less profuse hæmorrhage, incompletely 'expulsive,' in which some sight may be retained. In one of our cases the corneal flap was slowly pressed forward at the close of the operation. Then followed rupture of zonule and large loss of vitreous, but no blood appeared in the wound. A month later the patient could count fingers at 2 feet with this eye, but later the vision fell to moving bodies only, and the eyeball was shrinking. Again, in a Czermak's lower subconjunctival operation hæmorrhage occurred large enough to open the wound and raise the overlying conjunctiva, but there was no expulsion of vitreous. The pupil became closed, though the iris remained bright. An irido-capsulotomy, nearly a month later, failed to do good. The opening became occupied by blood, apparently from the vitreous. Later the eye was softening and the field of projection of light was contracting. A case of hæmorrhage complicating an iridectomy operation for chronic glaucoma in our practice is also of interest here. It was profuse enough to expel the lens with a quantity of vitreous and to distend the wound. But the patient a month later could count fingers at 9 inches. Before operation he could count them at 2 feet. Such cases link the more profuse and uncontrollable hæmorrhages with the small fundus hæmorrhages sometimes produced by operation in advanced glaucoma, and with those responsible for the condition 'malignant glaucoma.'

* For example, in one of our cases a large loss of vitreous followed an attempt to dislodge a bit of cortex by external pressure, but the flow of vitreous appeared to be at an end when the lids were closed. Half an hour later the patient was vomiting, and had considerable pain, and some little time afterwards the dressing was found soaked in blood.

H. Becker* reported a case of *arterial* hæmorrhage, apparently not expulsive, which began during operation and resisted treatment (including evisceration and packing and cauterization of the central artery) for four weeks.

Treatment.—Ordinarily a pressure bandage is applied, after excision of any portions of choroid or retina lying in the wound. If the bleeding does not quickly cease, a hypodermic injection of 20 minims of adrenalin chloride solution (Parke Davis's, 1 in 1,000) may be given, and 15 grains of calcium chloride administered every hour for some hours. This proved sufficient in all our cases, but various other measures have been found advisable or necessary at times. Ice has been applied and morphia injections given, and the upright position assumed. Trousseau advised the application of a sclero-corneal suture. Enucleation has been frequently performed. Formerly this was done more often than now, partly with the object of avoiding panophthalmitis. Evisceration and packing with gauze or gelatin has been done also.

Prophylaxis.—If it be decided to extract a cataract from the fellow eye after one eye has been lost from expulsive hæmorrhage, both general and local precautions are indicated.

1. Preliminary general treatment must be directed to lessen any circulatory disturbances and to lower the blood-pressure. Terson† recommends as preparation a suitable diet, little to drink, purgation, iodides, and tinctura veratri viridis, also chloral at night.

Abadie suggests egotin injection, and for twenty-four hours from the time of operation compression of the carotid.

2. A preliminary iridectomy is indicated, though in spite of this hæmorrhage has occurred at the subsequent extraction. Instead of the ordinary extraction, discission and linear extraction have been performed,‡ discission of a fully ripe cataract giving rise to little trouble in the eye. The cataract incision must be made slowly, in order that the ocular tension may not be diminished suddenly. And perfect rest must be maintained afterwards.

* Ref. *A. f. A.*, September, 1905.
† *Arch. d'Ophth.*, xiv (1894), 110.
‡ Peirone, *A. f. A.*, xxxviii (1899), 163.

VITREOUS ACCIDENTS.

The escape of vitreous humour from the eye has already received frequent mention. It predicates a perforation or rupture of the supporting diaphragm formed of suspensory ligament and lens capsule, also of the hyaloid membrane. In addition, an expelling force is needed. This is generally external pressure, by instrument, finger, or lids, or less obviously by action of the extrinsic muscles upon the eye; but occasionally the pressure is from within, from elasticity of the sclerotic, contraction of the tensor choroideæ (?), or intraocular hæmorrhage.

Prolapse and incarceration of vitreous in the wound, distinct from the actual flowing away of the humour, are minor grades of vitreous accident, but not necessarily of diminished gravity as regards the result. So far as one can judge they depend upon rupture of zonule or capsule alone, the hyaloid membrane remaining intact. They are comparatively infrequent except as brief preliminaries to expulsion. The whole length of the incision may be forced open by a narrow and low protrusion of vitreous showing no immediate tendency either to recede or to enlarge. More commonly the protrusion steadily increases in height and width, still further separating the wound margins, up to a certain point when it suddenly collapses more or less and vitreous flows away. The rupture of an invisible containing membrane is the obvious explanation of the occurrence. Should a simple prolapse remain stationary the same partial or complete collapse, with flow of vitreous, may be brought about by puncture with a knife or by partial excision of the prominence with scissors. Occasionally the vitreous may present at the wound without actually entering it; the corneal flap is pressed forward, causing the wound to gape a little.

The appearance of vitreous in the incision is in many cases preceded by a characteristic deepening of the anterior chamber, from vitreous entering through the pupil or through the coloboma. Very occasionally the humour may pass into the chamber thus without reaching the wound. In other cases the anterior chamber remains empty, and the iris is forced forward into the wound. If an iridectomy has not been made, the bulging iris retains the vitreous until the pupil dilates so widely that the whole breadth of the upper portion of iris lies exposed in the section, allowing the humour to pass out in front of it. The deepened chamber seems more likely to be met with when the zonule ruptures below, while the vitreous seems more likely to press the iris forward when the rupture occurs close to the wound above.

Vitreous expulsion most often accompanies or follows immediately the delivery of the lens. The escape may, however, take place as soon as there is a large enough opening made in the eyeball, or it may begin slowly without obvious cause just after the operation is finished. Rarely it may occur later during the healing process (Chapter V).

Since a flow of vitreous may possibly continue or recur after the eyelids have been closed and the dressing applied, estimates of the quantity lost can only be tentative. In any case they are very rough. Smith's losses at Jullundur are said to have consisted usually of only a small 'bead' of humour. In my experience quite small losses are the exception. The amount may vary up to about two-thirds of the total humour. Where the vitreous is of very fluid consistence some of it may pass through the wound without being noticed. The only evidence may be a slight gumminess of the fluid in the conjunctival sac. At times, therefore, one may feel uncertain as to whether a small

gush of vitreous has taken place or not. Not very uncommonly in large losses, the portion which comes first is of more or less reduced consistence, and it is followed by firmer normal material. In some cases the flow may prove to be in no degree controllable until a considerable quantity of humour has been lost. These eyes include some in which no other evidence of 'vitreous tension' has been observed. On the other hand, from slack and rigid eyeballs the humour has to be actually pressed out, and ceases to escape as soon as external pressure is removed.

Causes.—In ordinary cataract extraction the complication may be due to fault of the operator or assistant, or of the patient, or of neither. The cause is often quite obvious. Or again, one may feel at a loss to hazard even a conjecture as to the offending conditions or mechanism.

Of pre-existing conditions, the only one quite unassailable as constituting usually a sufficient excuse for the accident (though even here the accident is not always inevitable) is dislocation of the lens. Also there are cases of diseased eyes where dislocation, due to weak suspensory ligament and perhaps fluid vitreous, occurs during the making of the incision, however gently it be made. But the tremor of a Morgagnian, or formerly Morgagnian, cataract is not to be accepted as conclusive evidence of conditions more than feebly predisposing to accident. Exceptional gentleness and correct procedure are commonly effective in preventing complication in these cases. In similar manner, by prompt recognition, 'vitreous tension' is generally deprived of its peculiar danger. And the special tendency to rupture of zonule in eyes with much retracted conjunctival fornices applies only to extraction by ordinary section, and not to the subconjunctival operations. In eyes apparently sound apart from the cataract, occasional difficulty in determining

the real origin of vitreous complication may possibly be explained sometimes by the suggestion that the main cause is separated from the result by a definite interval of time. Damage done to zonule during the earlier stages of operation may not be made known until pressure is applied for the expulsion of the lens or of cortical remains. Or predisposition to accident may have been introduced by too deep a counter-puncture and too peripheral a section, depriving the zonule of the support usually afforded by the peripheral strip of cornea and by the sclerotic.

The loss of the support of the iris after a coloboma has been made has also been claimed as slightly facilitating rupture of the zonule. And very prominent eyes—*e.g.*, in exophthalmos and high myopia—are more liable to vitreous accident in that the lids contracting upon the globe obtain a greater purchase upon it.

Among the more obvious and immediate excitants distributed through the pages of Chapter II may be recapitulated:—a dragging incision; too firm or too heavy fixation; slipping of speculum; drag or pressure of cystitome or of capsule forceps; sudden upward movement of the eye with an instrument in the anterior chamber, or with curette resting above the wound, or with the upper lid insufficiently elevated; incautious pressure in expelling lens or cortex; difficulties in connexion with the toughened capsule of overripe cataracts; also painful or startling occurrences calculated to excite spasm of the orbicularis, such as a prick with the point of the knife near the inner canthus, or spurt of fluid upon the face from the irrigator.

There are puzzling spontaneous expulsions of vitreous about the close of the operation already referred to. Those which I have seen have not been in eyes with

noticeable vitreous tension. They at once suggest the onset of expulsive hæmorrhage, but the hæmorrhage does not take place, and the eyes commonly see well afterwards. In Bombay we have somewhat neglected our opportunities of examining these eyes for choroidal detachment later, such as would suggest that the vitreous expulsion had been caused by limited retro-choroidal hæmorrhage. Spasm of the tensor oculi muscle has been mentioned as a possible cause by Nicati.

Prevention.—From the very varied means of production of the complication it is obvious that endeavours to reduce its frequency must be comprehensive.

1. Among the more essential precautionary measures is the proper *control of nervous patients.* Excitable patients must be quieted by bromide or other sedative, by combining adrenalin with the cocain instilled, and by the surgeon's influence during operation. A trained assistant is important to take charge of the stop-speculum, which must be removed promptly if the patient shows signs of losing control over his orbicularis muscle. If the patient fails to pass the prescribed tests beforehand, a subconjunctival operation should be performed.

2. The latter method should be adopted also when conditions present in the eye predispose to vitreous accident (Chapter IV).

3. In particular *gentleness* must characterize the surgeon's procedure throughout. The remarks made in Chapter II must be borne in mind regarding dragging incision, over-firm fixation, cautious capsulotomy, and especially slow expression of the lens and careful dealing with cortex.

4. *Watchfulness* and *caution* are mainly matters of experience, to promptly detect and remove direct causes of accident and excitants of lid spasm, and to guard against injury by sudden movements of the globe. The situation

must be saved if necessary by bringing the operation to a close without completing the 'toilet' of the eye.

An additional, but an unfair, means of reducing one's percentage of accident would be the rejection of complicated cataracts and dislocated lenses.

Our vitreous losses in Bombay in 1,262 flap extractions performed during 1905 and 1906 totalled thirty-eight—*i.e.*, 3 per cent. (Cases are not included in which the loss was preliminary to expulsive hæmorrhage.) Of the thirty-eight, sixteen escapes may be classed as avoidable, seven excusable, and fifteen unavoidable.

For the sixteen avoidable accidents I accept the responsibility. Eight of the losses were caused by the patients squeezing their lids forcibly together. But this might have been prevented in many cases by securing more complete anæsthesia with adrenalin and cocain, and by other precautions. Six of the accidents were due to ill-performed operations by downward section, three by ordinary flap incision, three by Czermak's scissor method. I was at the time inexperienced in both of these methods. Another loss was ascribed to the use of a rather blunt knife, and another to accidental puncture of the posterior capsule (in a case of traumatic cataract).

The seven excusable accidents were all in connexion with toughened capsules of overripe cataracts. Against these may be set other extractions, intracapsular and otherwise, where from extreme overripeness, dislocation, and so on, loss of vitreous was anticipated, but was avoided.

The fifteen unavoidable cases included no less than eight spontaneous escapes, and seven others accounted for variously, by existing dislocation of the lens (three cases), ectopia lentis (one), occluded pupil with fluid vitreous (one), and atrophic zonule (two cases; in one the vitreous escaped during the making of the section, and in the other the lens became dislocated during the cutting).

Thus the losses might with extreme care have been possibly reduced by about one-third of the total. The actual figures, however, are not of much value for application elsewhere. So much depends upon the class of patients, and the proportion of diseased eyes and overripe cataracts. It may be safely laid

down that in countries where cataract is commonest the proportion of complicated cataracts will be lowest. On the other hand, in India the cataracts are very much more often allowed to become overripe than in Europe and America.

Elliot* (Madras) had only 2·7 per cent. of vitreous losses in 2,000 consecutive extractions. Maynard† (Calcutta) reported 6·3 per cent. of losses in an earlier series of 1,000 operations, 4·3 per cent. in a later similar series.

Management of Cases.—When vitreous escape is due to spasm of the lids, usually our first concern is to remove the speculum before further harm can be done. But it is often necessary to adjust the margins of the incision. This may sometimes be done with the speculum still in position, otherwise with the lids controlled by the assistant's fingers or with Desmarres' retractor. Where a large loss has been occasioned by external pressure alone there is more or less collapse of the globe. The corneal lip of the incision generally falls back behind the scleral lip; or it may override the latter considerably. In the former case the conjunctival flap must be drawn up over the peripheral lip. Some surgeons have filled the anterior chamber with saline solution, to obtain better adjustment of the wound margins, but it is unnecessary. In tenser eyeballs the wound may still remain occupied by a projecting mass of firm vitreous, just as when prolapse alone occurs without loss. It is advisable to cut away some of this projecting material with scissors. This does not lead to immediate coaptation of the wound margins, but in my experience it secures their readjustment within twenty-four hours. The snipping away of a simple prolapse is imperative. This must be done as quickly as possible, and the patient is not asked to turn his eye strongly downwards, lest additional expulsion of vitreous be thus

* Personal communication.

† *Ind. Med. Gazette*, xli (1906), 315.

brought about (through the pull of the recti muscles tending to open the wound, and their pressure tending to expel vitreous).

Should a wide prolapse of iris lie in the wound also, much of this may be excised at the same time, but usually without the aid of iris forceps. The globe cannot be fixed with forceps, and if not kept quiet by the patient it may be impossible to remove the iris. Should the vitreous have escaped before an iridectomy has been made, and should the iris have been pressed back within the globe by the humour passing in front of it, the iris should not be interfered with.* There is little or no risk of subsequent prolapse. The upper portion of the iris may have already receded partly or completely behind the scleral margin.

A narrow incarceration or mere presentation of vitreous causing the wound to gape but slightly is left in the hope that it will recede.

Both eyes are bandaged carefully, without pressure upon the operated one. The greatest care is necessary at the earlier dressings not to cause a recurrence of vitreous escape. The eyelids need be scarcely separated, and the lower lid must be kept well away from the eye. After several days, if the wound is still not closed and the eye is no longer quite soft, the application of a pressure bandage is indicated.

Consequences.—In most cases there is next day no longer any evidence of the mischance; the healing goes on normally and the consequences are *nil.* Very occasionally the wound remains open with vitreous *impacted* in it. If the wound margins are only a little separated, their approximation generally takes place under a pressure

* The use of a sharp hook has been recommended for drawing out the iris for excision.

bandage. But sometimes this does not happen, and in the case of a wide incarceration is not to be expected. The exposed vitreous soon becomes opaque from infiltration, and later acquires firmness from the formation of fibrous tissue in it. Thus cicatrization progresses with the corneal flap considerably displaced. A high degree of astigmatism persists. The anterior chamber may fail to reform for a long time, and opacity of the posterior layers of the cornea—'contact keratitis'—may develop. And opaque bands may spread from the impacted tissue into the vitreous, further interfering with vision, and tending to draw the retina forward and to cause detachment.

The exposure of the vitreous, and later, the ectatic scar which develops, must open the way more or less permanently for possible *infection* of the eye. Even when the wound is found well adjusted at the first dressing, it may have been kept open by vitreous for some hours after the operation. It is only fair to attribute to this source some of the infective inflammations which follow early or late. For experience in discission operations has shown that numbers of eyes have been lost by suppuration through impaction of minute threads of vitreous in needle punctures. Bacterial invasion of the eye may be further aided by the healing of iris in the wound, prolapsed or incarcerated. Even where an iridectomy has been performed impaction of iris frequently occurs at the two ends of the incision. One is afraid to attempt excision of the displaced iris on account of the risk of causing renewed loss of vitreous.

It is said that, apart from the risk of secondary infection, the prognosis of cases with vitreous healing in the wound is bad, and that many of the cases end in atrophy of the globe.*

* Czermak, 'Die Augen. Op.,' S. 943.

Impaction of firm vitreous in the wound is seldom seen after loss during operation if the projecting mass has been rather freely cut away. I had gained an impression from Bombay work that incarceration during the healing process was to be found only in cases where vitreous had not actually escaped, and where, therefore, the hyaloid membrane might be still intact. Elliot (Madras) has kindly given me his experience on this point. He had fifty-eight vitreous escapes in 2,000 extractions. In eight of these cases the section gaped for variable periods afterwards. Among these cases one pupil became occluded, and there were two other very poor visual results. Besides these accidents, there were six other cases in which impaction occurred at the time of operation or later, though there was no vitreous escape. These eyes all obtained good vision, and a finally closed section is mentioned in all but one case, in which a hypopyon formed.

Many cases in which the wound heals up normally show an evidence of anchoring of vitreous to the scar. Possibly in these cases fine threads or films of vitreous tissue become incorporated in the scar. The evidence consists in a striking and characteristic *enlargement, distortion, and displacement of the pupil,* without impaction of the iris or adhesion of the iris to the wound. It is mostly seen after large losses, but I have seen medium and minor grades of the abnormality where no vitreous accident of any kind had been noticed at the time of operation. Probably in at least some of these cases expulsion of vitreous may have taken place after the application of the bandage.

In the typical condition as seen after large losses the appearance is as though an enormous iridectomy had been made. It is the same whether an iridectomy has been actually performed or not. The upper half of the iris has disappeared, retracted behind the scleral margin. It can be seen, however, by focal illumination, narrowed, immobile, and irresponsive to eserin.

The pupillary margin of the lower half of the iris arches

across, only slightly curved, about or above the middle of the cornea, to disappear at either end behind the sclera (Fig. 73). It reacts but little or not at all to light.

In the minor grades of abnormality the retraction of the iris is less complete, and the widening of the pupil laterally is not extreme. The upper narrowed strip of

FIG. 73.—DISTORTED PUPIL.

iris lies behind the cornea. Even here the division between the two portions of iris may be quite sharp, though I do not know if it is always so.

In some cases, at least, the plane of the atrophic iris

FIG. 74.—DISTORTED PUPIL.

is distinctly posterior to the scar line. But in old cases where the upper part of the iris has practically disappeared, the condition may perhaps closely approximate to that

Fig. 75.—DISTORTED PUPIL.

brought about by adhesion of capsule and of iris to the scar.

Though the retraction of iris may be well marked at the first examination twenty-four hours after operation, the portion of iris then involved may be only small. It may increase gradually later, with progressive widening and

drawing up of the pupil. And the narrowed iris in the course of months may become still narrower and markedly atrophic, and probably may disappear altogether.

Fig. 74 (*a*) shows a condition seen eleven days after operation on the discharge of the patient from hospital. Two months later this condition had changed to that shown in Fig. 74 (*b*). The remains of iris above were almost unrecognizable—merely a narrow, pale greyish band, with its lower margin dark towards either end. Fig. 75 (*a*) shows a condition of pupil found on the first day after an extraction by Czermak's lower section. There had been no presentation or loss of vitreous, but there had been evidently rupture of the zonule above, for the upper edge of the capsule was to be seen later in the distorted pupil. At the time of discharge from hospital the distortion and enlargement of the pupil had increased, as shown in Fig. 75 (*b*).

Though Pope and Elliot (both of Madras) have referred to this distortion of pupil, the only description of it, so far as I know, has been in my 'Practical Details of Cataract Extraction.'

The fixation of the vitreous to the scar is supposed to tend towards later *detachment of the retina*. But detachment may follow also without this adhesion. This is the result which we fear most after large vitreous loss. But often it does not take place after very large escape, even from myopic eyes. The connexion between vitreous loss and retinal detachment is undoubted, but we need much more exact knowledge of the subject than we now possess. Sometimes after vitreous expulsion the tension of the eye is late in being re-established. And after the largest losses, especially repeated losses, the eyes may become rapidly atrophic. One fears a bad result from vitreous accident in the not infrequent cases in which long floating threads of opacity are found in the vitreous at the time of discharge.

In a recent Bombay case in which there was detachment of the retina and low tension after a vitreous escape, the clear area of the coloboma above an opaque patch of capsule occupying the pupil became slowly covered by a grey exudative film, though there was no ciliary injection or other evidence of inflammation. The edges of the wound were in good apposition.

Opinions are widely divided as to the gravity of the dangers from loss of vitreous. Smith of Jullundur, the world's biggest operator, maintains that small losses are harmless, and states that nearly all of his escapes are quite small. Major Birdwood, I.M.S.,* after a large acquaintance with vitreous accident, says: "Provided the capsule (of the lens) is unruptured no evil effects whatever seem to follow the escape of vitreous even when in fair quantity." These opinions, however, are not shared by surgeons in Europe and America, who are able to follow up their cases. And even in India a very different picture has been drawn—from the records of the Calcutta Ophthalmic Hospital.†

Among 122 operations complicated by vitreous expulsion there were 28 failures—presumably failures recognized before discharge from hospital. In 9 cases there was atrophy of the globe. The other failures were all apparently infective—10 by iritis, 8 by corneal sloughing, and 4 by panophthalmitis. Twenty-two of the 122 losses were large, amounting to more than a fourth of the humour. And there were only 5 failures among these 22 cases. So that it was held that the question of the quantity lost had very little influence upon the result.

I have seen early shrinking of the globe rarely, and simple detachment of the retina rather more frequently, either before the patient's discharge or a few months later; but I have no figures bearing upon the relative frequency of these results. I have thought that after escape of

* *Ind. Med. Gazette*, xli (1906), 201.

† L. M. Mookerjee, Trans. Ind. Med. Congress, 1894.

vitreous in our practice infective losses were more frequent.

For instance, in a series of 578 extractions, there were 3 severe inflammations leading to atrophy. Two of the 3 cases occurred after loss of vitreous. It may be noted also that among 9 large vitreous losses reported by Smith* there were 3 suppurations. In the matter of infection the quantity lost can have little bearing. Probably Smith's relative immunity from infective losses is attributable to his preliminary douching of the conjunctiva with 1 in 2,000 perchloride.

* *Ind. Med. Gazette*, xl (1905), 327.

CHAPTER IV

VARIATIONS IN PROCEDURE, AND THEIR VALUE

General preliminary and preparatory details—Fixation—The section—Simple extraction—Peripheral iridectomy—Preliminary iridectomy—Other modes of opening the capsule—Intraocular irrigation—The open treatment of the wound—Extraction of the lens together with its capsule—Asepsis—Results.

GENERAL PRELIMINARY AND PREPARATORY DETAILS.

The Value of the Mouth-Mask or Screen.—It is well realized nowadays that *salivary infection* of wounds is a danger seriously to be guarded against. But an extensive face covering in the form of a veil is scarcely called for, since the expired air in breathing is harmless. In Smith's Jullundur work the screen is superfluous, since neither he nor his assistant find it necessary to speak to the patient during operation; but in ordinary work many of the patients need repeated verbal directions. I have little doubt that some of our earlier Bombay infections were from this source. We thought, immediately after the use of the screens was begun, that there was a decided and continued improvement in the average appearance of the eyes after operation. We thought there were fewer muddy pupils and irises seen requiring early treatment. Axenfeld* has remarked that infection in eye operations is almost exclusively by the pneumococcus, which is rare in the healthy conjunctiva, but common in the saliva.

Some surgeons lay stress upon the cleansing of their own and of their assistants' hands, passing them through the regulation brushing with soap and water, steeping in alcohol and in

* *Klin. M. f. A.*, xli (1903), 2, 474.

1 in 1,000 sublimate. And they wear sterilized blouses and caps. De Schweinitz sprays the nasopharynx three times daily with a solution of permanganate of potassium, 1 in 5,000, as a preparation for cataract extraction.

The casual references made in Chapter II to the **Cleansing of the Lids** and surroundings, and especially of the lid margins, will be regarded by many as quite inadequate. They represent the general practice in Bombay and, I believe, in India generally—a practice based less upon conviction than upon an insufficient supply of reliable assistants and attendants. We frankly took up the position of making no attempt to sterilize these surfaces, or even to clean them thoroughly. We recognized these surfaces and the eyelashes as possibly foul, and undertook the responsibility of preventing contact between the lid borders and lashes with the portions of instruments which entered the wound. Particular care in this respect was exercised in making the incision, as already insisted upon. But under more favourable circumstances it would seem wise to devote more attention to the lid margins at least, even admitting that complete sterilization cannot be attained. This is suggested by the bare possibility that the surgeon may fail to notice accidental contact of the blade of the knife with the lashes or skin before the incision is completed. Considerable importance has been laid also upon the lid margins as one of the main sources of supply of conjunctival bacteria (see also the section on 'Asepsis'). Hence, thorough cleansing of the skin may tend to lessen the risks of secondary infection of the wound. At the same time, care must be taken lest more harm than good should follow too energetic efforts, by exciting inflammation.

A common practice is to cleanse the skin of the lids and neighbouring parts thoroughly, either on the preceding

day or on the morning of operation, and then to cover the parts with a compress moistened with antiseptic fluid, until immediately before operation. At this time a final cleansing is practised. The initial washing is first with soap and hot water, then alcohol, and then, perhaps, sublimate lotion, 1 in 2,000, care being taken that none of these irritants reach the conjunctiva. The compress is soaked in 1 in 5,000 sublimate, and covered with guttapercha tissue.

There is no objection to covering up the eye thus for an hour or two before operation, but applied as a 'test dressing' from the preceding day, the compress continued up to the operating period is objectionable. If continued for more than a night—the normal period of closure in sleep—the immobility of the lids and the warmth of the dressing favour the growth of micro-organisms in the conjunctival sac, and often excite slight temporary hyperæmia. A few hours should be given for this to subside. The prolonged application of weak perchloride solution to the skin excites an acute discharging dermatitis in a few people. It is urged against all 'test dressings' that they are apt to disturb the patient's sleep, so much needed the night before operation.

Epilation of the cilia, of the whole of both lids, or of the upper lid only, has been practised by a few surgeons. It is, of course, a painful procedure, and may cause inflammation. On these accounts it is more usual to cut the lashes short. But even this is not required except at the outer portion of the upper lid beyond the point where the arm of the speculum crosses the lid border.

Here it is necessary if the blade of the knife is to be guarded from contact with the eyelashes in making the incision. But there is no difficulty in preventing the portions of instruments which enter the wound from touching the lashes of other

portions of the lids. If there were any such difficulty, it could be avoided by the use of specula with plates or bars, such as Lang's or Koster's.

It is recognized that the cilia and the lid margins cannot be made certainly sterile by ordinary washing with soap and lotions. Benzine introduced by Pflugk* and used by Kuhnt, Mayweg, and others, has been recommended as a cleansing agent.† It is non-irritant, provided its action is confined to the skin surface. The swabs dipped in it are squeezed nearly dry. De Wecker applied 1 per cent. cyanide solution to the lashes. Panas, Truc (Montpellier) and Louis Dor (Lyons) have used a solution of biniodide of mercury in oil for the lid margins. (Panas' solution is 4 in 1,000.) Hess, after washing with 1 in 2,000 sublimate solution, applies sublimate vaseline, 1 in 1,000.

The cleansing of the lid borders is facilitated by cutting short, and still more by pulling out, the lashes. Also, after operation, the lids cannot be glued together by secretion, and the latter is easily washed away.

Expression of the contents *of Meibomian glands* as a part of the routine preparation of the patient is, so far as I am aware, exclusively a Bombay practice. It was forced upon us by our free use of intraocular irrigation. Any operator who separates the lids with a speculum, and uses the ordinary irrigator for washing out cortex, must at times have noticed the Meibomian secretion floating upon the fluid in the conjunctival sac; and once having seen the material which can be expressed from sluggish glands, he will continue in a routine effort to remove possibly infective material. This emptying of the glands appears to be essential if the lid borders are to be maintained clean

* *A. f. A.*, xlv (1902), 176.

† The benzine may act slightly as a disinfectant, but its main action is as a powerful solvent of fats.

throughout a cataract operation. It seems especially necessary in operations where the lower lid border is utilized for applying pressure upon the eye for the expulsion of the lens and of cortical remains.

Some operators prefer to cover the greater part of the patient's face with sterilized gauze, leaving only the eye and its immediate neighbourhood exposed.

The eyebrow, regarded as unsterilizable, has been shaved by a few surgeons, *e.g.*, Haab, Czermak, lest bacteria should be transferred from the hair to the surgeon's hand, and this indirectly to the instruments. Also lest organisms should be carried down by perspiration in summer to the lid margins (Haab).

General Anæsthesia.— *Chloroform* is practically never needed in cataract extraction in adults. If a patient, insane or otherwise, be so deficient in self-control that Czermak's operation by lower subconjunctival section cannot be performed, he will not be a fit subject for operation, because of the care needed to prevent accident during the healing period. And in the case of painful glaucomatous eyes temporary measures can be employed to reduce tension till the eyes are fit for operation. The only occasions on which one might be compelled to use general anæsthesia, would be when a patient became uncontrollable during operation. But of late years I have not met with such.

Apart from the question of risk to life, chloroform is objectionable, because of the danger of prolapse of iris or loss of vitreous occurring afterwards from vomiting. More time is taken up by the operation, and unless the patient be kept completely under the influence of the anæsthetic, inconvenience is occasioned by the eyeball rolling upwards.

In operating upon children by linear extraction chloroform may be needed, but the quantity given may be much reduced if cocain be instilled into the eye, as usual, also.

General anæsthesia by subcutaneous injection of scopolamine and morphine has been recommended by Suker* and

* *Medicine*, January, 1906.

Segelken.* One-fiftieth of a grain of scopolamine hydrobromate (Merck) and half a grain of morphine sulphate are dissolved in three drachms of distilled water. One Pravaz syringe full of this solution is injected three hours before operation, and a second similar dose given one and a half hour later. A few drops of cocain solution are instilled before operating. Although the patient is apparently comatose, he can turn the eye in any direction when asked to do so. The solution 'Skopomorphin' can be obtained sterilized in tubes from J. D. Riedel, Berlin.

The Cleansing of the Conjunctiva.

The value of *perchloride irrigation* of the conjunctiva before operation, and its mode of action, are discussed at the end of this chapter, under 'Asepsis.' The fairly general affection evinced by eye surgeons for sublimate lotion is based upon wide clinical experience. This solution has been much more extensively tested than any other antiseptic fluid, in spite of the irritation set up by it. And the explanation is that its usefulness depends mainly upon its action on the conjunctival tissues. Laboratory research showed years ago that there was little prospect of success in the search for an effective but unirritating conjunctival antiseptic. And according to present evidence, it would be a mistake to attempt to replace the perchloride by cyanide of mercury solution, or by other antiseptic fluids, which, with a given bactericidal power, produce less irritation.

The drawback to the use of the perchloride is the inflammatory reaction set up by it. But our Bombay experience shows how, by adjustment to individual needs, the reaction can be kept within bounds. Any unusual degree of conjunctivitis excited is in itself but a slight temporary inconvenience, of no real consequence whatever.

* *Klin. Monats. f. A.*, Juli, 1907.

It is gratifying to the operator that the eye should remain free from noticeable reaction, but it is necessary to distinguish between personal gratification and actual benefit to the patient. It is, of course, better to irritate a hundred eyes than to lose one by suppuration. It might be anticipated that this traumatic inflammation might occasionally tend to favour secondary infection of imperfectly healed wounds. For such reactions are known to encourage the multiplication of pathogenic cocci in the conjunctival sac. But no clinical evidence is forthcoming of wounds being thus influenced. Excessive reaction, however, may do harm by simple spread to the deeper tissues of the eye. Where much lid swelling is occasioned by the conjunctival application, it is reasonable to suppose that some slight injection of iris and ciliary body may be set up from the surface irritation, such as may be observed commonly with any slight corneal lesion. And this, acting together with other causes of iritic reaction, may assist in the development of iritis. Practically the extent of this drawback, as seen clinically, consists in the need for more atropin after operation than would otherwise be used. Another point frequently scored against perchloride is that by injuring the tissues it renders them less able to cope with any pyogenic organisms. But since the lotion does not gain access to the wound and is only applied to the conjunctiva beforehand, the objection does not apply. Where no pathogenic organisms are present even simple mechanical cleansing, if at all vigorously carried out, may be objected to as causing a slight unnecessary reaction.

The ideal procedure would be the determination of the presence or absence of pathogenic organisms, and such preliminary treatment of the conjunctiva as proved necessary to remove these inhabitants. Some attempt has been made in this direction, *e.g.*, by Freeland Fergus.

Simple cultures upon Löffler's serum, supplemented occasionally by subcultures, supply fairly definite information. One would prefer not to operate, as we found we were doing in Bombay, in the presence of pneumococci or streptococci, orange or citron staphylococci, or diplo-bacilli, or even of numerous white staphylococci. Freeland Fergus* is of opinion that the *Staph. albus* does not cause suppurations, or even iritis or irido-cyclitis, but if present in considerable quantity, almost invariably gives rise to conjunctivitis after operation.

Had there been means and opportunity in Bombay, however, for carrying out bacteriological examinations at a sufficient interval before operating, the knowledge obtained would have been an embarrassment, and would have lessened the usefulness of the hospital. We would have feared to operate in many cases even with the help of perchloride, and would have kept patients attending for outdoor treatment until many of them would have fallen into the hands of the couching quacks.

Bacteriological examination would be appealed to more commonly did surgeons feel perfect confidence in the result. One fears to place implicit trust in a negative result, which may possibly, by some rare chance, be due to faulty technique. There is also the feeling that a few dangerous microbes may escape detection, lying in folds or recesses. Probably, however, such scattered organisms are of little account, for it is recognized that a certain dosage is required for the effective lodgment of pyogenic organisms in a wound. However this may be, it was curious that the one complication, presumably infective, which occurred among our fifty cases bacteriologically examined (see later) was in an eye in which the test gave no warning of danger.†

* *Brit. Med. Journ.*, March, 1905.

† It was one of our rare cases of occlusion of the pupil from iritis. But the iritis was not very severe ; there was neither much injection of the eye nor much exudation. The closure of the pupil came as a surprise, and was apparently largely due to the treatment being at first very mild. From the conjunctiva after perchloride irrigation only one colony of white staphylococci was grown, while the tube inoculated before irrigation furnished eight colonies of white staphylococci and two small moist pits suggestive of early diplo-bacillary colonies, which, however, did not develop.

Separation and Control of the Lids.

The advantages of the stop-speculum are somewhat more evident in dealing with deeply set eyes than with others, for the risk of vitreous accident from contraction of the orbicularis is least in these cases, and wide separation of the lids is most needed. The danger of vitreous expulsion, in so far as it is due to the speculum properly elevated, is explained by the fact that the peripheral fibres of the orbicularis muscle are alone able to press upon the eyeball. The elevation of the tarsal portions of the lids leaves the front of the globe unsupported, and the corneal flap can be thus forced forwards. Hence it has become customary to insist upon some provision for very rapid removal as one of the essentials in the design of a satisfactory speculum. There is no such provision in the screw adjustment, which is the only stop mechanism with which I have had extensive experience; and I have not found the want of it noticeably embarrassing. When harm is done by spasm of the orbicularis, it is nearly always at the first moment of the contraction. The muscle is commonly relaxed again at a sharp word of command from the surgeon, and the instrument is readily withdrawn before further contraction can take place. Automatic removal, brought about by the actual contraction of the lids, as in Müller's speculum, is the only mode of removal rapid enough to guard the vitreous effectually. And the sudden closure of the lids permitted may do harm should any instrument be in the wound at the time or should the iris be in the grip of the iris forceps, or should the wound be gaping widely, with the lens lying in it. Again, violent contraction of the orbicularis is frequently foreshadowed by preliminary twitches or blinkings, which serve as a warning for

removal of the speculum, and substitution of other means for separating the lids. Our figures (p. 169) show how infrequent vitreous accident from spasm of the lids may be, in working with the ordinary screw speculum under the general precautions indicated in Chapter III.

With Desmarres' retractor in the hands of an experienced assistant, powerful spasm of the orbicularis may be effectually resisted without endangering the vitreous, except, perhaps, in the case of unusually prominent eyes. Yet it is extraordinary sometimes how the muscle is able to exert pressure upon the globe, with the retractor firmly pressed against the roof of the orbit. With the stem bent as shown in Fig. 41 the instrument can be used more effectively to control the action of the orbicularis muscle, but it is not so easily withdrawn when the muscle is contracting.

In Chapter II separation of the lids by the assistant's fingers is considered only as a substitute for the use of the speculum after the section has been completed. But a few surgeons employ it in making the incision, *e.g.*, Sir Anderson Critchett. When working without an assistant, this operator elevates the upper lid with the ring finger of the hand holding the fixation forceps.* Trousseau† (Paris) employs his own finger and thumb for separation of the lids and for fixation of the eye. The chief objection to control of the lids by the fingers alone, apart from its comparative ineffectiveness, is an inadequate protection against infective risks.

* *The Ophthalmoscope*, iv (1906), 112. Critchett says: "The sensitive natural speculum possesses this great advantage, that it can recognize the beginning of a spasmodic effort on the part of the patient, and can at once give the necessary relaxation, and as the section is nearing its completion, the gradual withdrawal of the finger allows the lids to close gently and without effort."

† *La Clinique Ophtal.*, November 25, 1905.

When the lids have to be released on powerful spasm occurring, the edge of the corneal flap, possibly with the conjunctival flap lying over it, deep surface foremost, sweeps upwards in contact with the conjunctiva of the upper lid. And should closure of the lids occur with the lens half out of the wound, the corneal flap may be carried down by the bacteriologically unclean border of the upper lid, and thus possibly the zonule ruptured, vitreous lost, and the interior of the eye widely exposed to any bacteria present in the conjunctival sac. Should this accident occur, the lower lid must be firmly depressed by the assistant, while the upper lid is elevated by pulling on the lashes, or, if necessary, by the insertion of Desmarres' elevator, and the flap replaced by the curette.

Angelucci raises the upper lid by means of the fixation forceps gripping the tendon of the superior rectus.

FIXATION.

Some operators who complete as much as possible of the section in the first inward stroke of the knife, fix the globe with forceps at the inner side of the cornea, to resist the thrust of the knife. The forceps applied here may be of some slight service in defining the site of the counter-puncture. In our work with a gentler use of the knife, fixation is more needed below to resist the upward pull in the sawing movements of the blade.

Angelucci's Method of Fixation.—Fixation of the globe by gripping the insertion of a rectus muscle (the internal) with forceps through the conjunctiva was practised by Macnamara. Angelucci* is warmly supported by Gutmann† in claiming special benefits derived from his method of fixing the eye by grasping the tendon of the superior rectus muscle. He performs simple extraction through an upper section comprising little more than one-third of the corneal circumference, and incises the lens capsule with the point of the knife as it passes across the chamber. The fixation forceps serve not only to fix the globe, but also to elevate the upper lid. They should

* *Arch. di Oftal.*, vi (1899), 260.

† *Bericht der xxx Versamm. der ophth. Ges. in Heidelberg*, 1902, S. 239.

have ends 3 millimetres broad, and teeth not very pointed. Angelucci dispenses with an assistant, and does not depress the lower lid. The upper lid is first well elevated by the thumb of the right hand, while the forceps, held in the left hand, and pressing deeply, seize the conjunctiva and the underlying tendon 4 to 5 millimetres from the corneal margin. This hold is maintained while the various steps of the operation are performed with the right hand.

It is stated that the fixation so close to the section entirely immobilizes the eye, and the making of the section is consequently very easy. The forceps serve for counter-pressure in expelling the lens in the ordinary way with Daviel's spoon. The pressure required is only light, and therefore there is little risk of vitreous accident, and rarely any injury to the iris or any prolapse. The return of the iris within the chamber is facilitated by the forward pull of the forceps on the scleral margin of the wound. In senile enophthalmos and in blepharophimosis the forward pull of the forceps is an advantage. It would seem that the hold on the muscle must be frequently painful, and therefore likely to excite spasm of the lids.

THE SECTION.

Variation in the style of cutting is optional, thus:— Many surgeons attempt always to complete the section in one double movement of the knife, in and out. This may frequently be accomplished with a fairly broad and sharp knife. Czermak used a blade 3 to 3·5 millimetres broad. Critchett and Kuhnt have employed the knives already described.

It is by no means always possible, however, to finish the section thus simply and rapidly without using more force than one may consider advisable. This is particularly so whenever a long sweep* of the knife is impracti-

* A slightly longer movement of the blade is practicable if the eye be turned a little outward, or if the same effect be got by keeping the eye fixed and turning the head a little to the other side.

cable—in sunken eyes, therefore, and in those with contracted palpebral aperture.

When it can be effected easily, the incision by this one to-and-fro stroke presents two claims upon our consideration: (1) It makes a wound with perfectly smooth level surfaces. And such wounds are much more likely to unite rapidly and firmly than others somewhat jagged and uneven. This is important in operations where the conjunctival flap is dispensed with, or where only a small apical flap is made. And more especially so if at the same time no iridectomy is made, since early union is relied upon to prevent prolapse of the iris. (2) An advantage much more appreciated in simple than in combined extraction is that some aqueous is retained in the chamber during the greater part of the cutting. Thus injury to the iris by the knife is prevented, and this is an additional safeguard against subsequent prolapse.

There are two drawbacks to this mode of cutting: (1) The higher degree of force that one is tempted to exert to complete the incision with a knife which is beginning to lose its edge must endanger a weak zonule. And this ligament may be further endangered by any slight twist of the broad blade which may be required in following the edge of the cornea upwards, causing the back of the blade to press upon the lens and iris. (2) This mode of cutting does not afford facilities for shaping any conjunctival covering except at the summit of the wound, for so much of the incision is accomplished in the mere puncture and counter-puncture by a very broad Graefe's knife. And the fashioning of anything approaching a complete conjunctival flap depends so much upon the slight alterations in the plane of the blade which are practicable during sawing movements, that it is found that the narrower the blade the more nearly can one succeed

in the difficult outlining of any particular design of conjunctival appendage.

On the other hand, the narrower the blade the more often will the iris be cut or scraped by it, owing to escape of aqueous before the edge of the knife has passed well up in front of the iris. This in spite of the fact that slight alterations in the plane of the narrow blade may often be made without appreciable loss of aqueous.*

Thus, in our work, wanting always a moderately complete conjunctival covering, and, though frequently attempting the simple operation, more frequently ending with the combined, we found the blade of medium width, 2 millimetres exactly, most satisfactory. It was not too broad for the cutting of a satisfactory conjunctival flap, and was yet broad enough to obviate frequent injury to the iris.

A narrow blade is more easily guided across a very shallow anterior chamber, pressing less against the lens and iris.

If one attempt to accomplish the whole or greater portion of the section in one movement of a medium or rather narrow blade, the push of the knife is somewhat apt to force out aqueous and iris through the wound at the inner side below the knife.

The **Conjunctival Flap** serves several purposes:

1. Its chief function is as a protection against infection of the eye. Serving as a covering for the wound, it must bar the entry of micro-organisms from the conjunctival sac after the operation. And for this purpose, the more

* The slightest twist of a broad blade at once empties the chamber of aqueous. In our earlier practice we found the iris more often injured by broad-bladed knives. But this was due to want of care in placing the blade correctly before beginning the incision. One of the chief objections to the old broad Beer's knife was the difficulty in altering its plane during the making of the section.

complete the covering, presumably the more effective should it be, especially in eyes where vitreous tends to press the corneal flap forward. It is doubtful, however, whether in ordinary cases a protective covering is in any degree necessary or advisable, except about the middle of the wound—at the summit of the arch. It is here that any gaping of the wound tends to be widest.* And it is here, also, that micro-organisms are most likely to be worked into the wound from the overlying palpebral conjunctiva by movements of the eyeball, since uncontrolled movements after operation, just as during operation, are presumably mostly in the vertical direction. And probably the making of even a small localized flap may be considered indirectly to guard against secondary infection to some extent by ensuring that a portion of the incision traverses vascular scleral tissue.

It is not unreasonable to suppose further that the protective influence, as regards infection, which we attribute to the conjunctival flap, is exerted partly during the actual operation.

The mere covering then appears to be of little value, unless, possibly, to screen the eye from the operator's saliva in speaking. But the cutting of the flap provides a strip of raw sterile surface, enlarged by retraction of the elastic membrane, over which instruments pass in entering the eye. Thus the instruments are not likely to carry in conjunctival organisms. If the conjunctival flap be left in place, instruments inserted beneath it have to pass between two active raw surfaces, likely to rub off loose bacteria from the instruments, and well able to dispose of them subsequently.

2. The very rapid adhesion of a conjunctival flap to the underlying tissue must undoubtedly tend to prevent

* It is understood that reopening of the incision towards either end from prolapse of iris is at once remedied by excision of the prolapse.

prolapse of iris. But this statement needs qualifying greatly. Since a cataract incision largely covered by conjunctival flap must be at least partly sclero-corneal, this peripheral situation of the section, as compared with one at or in front of the limbus, is calculated to more than counterbalance any benefit derivable from the conjunctival covering. For another reason, any value attributable to the conjunctival appendage as a preventive of prolapse is restricted mainly to the smaller conjunctival flaps (see below).

3. The use of the flap makes the complication, delayed union of the wound, as shown by non-retention of aqueous, a rare one and almost a negligible one. Should the complication occur, it will not persist for long, and will not require treatment, and there is no fear of down-growth of surface epithelium into the anterior chamber, with its subsequent liability to induce probably incurable glaucoma.

4. We attributed our almost complete exemption from secondary glaucoma in Bombay cataract work mainly to our very general use of an extensive conjunctival flap. A permanently filtering cicatrix—rendering rise of tension practically impossible — appears to be the constant and inevitable result of any recognizable separation of the sclero-corneal incision under the conjunctival covering.

5. A quite minor advantage of the conjunctival appendage is in the use that may be made of it to draw open the wound during operation, for the iridectomy and in the expulsion of the lens.

Drawbacks.—(1) During operation it may be a little in the way when the iris is being cut, but the chief trouble from it then is (2) the hæmorrhage into the anterior chamber, which is to be expected more or less with any extensive flap unless adrenalin solution has been in-

stilled. This blood is not only a nuisance at the time, interfering with the capsulotomy and with the removal of cortex, but also afterwards. A little of it may become organized, causing permanent after-cataract and synechiæ. The bleeding is to be more carefully guarded against in intracapsular extraction, since here the blood cannot well be washed away. Still, these are not very serious matters. Also may be mentioned as a slight drawback (3) the difficulty experienced in outlining the flap exactly as one wishes. (4) After operation the separation of the deep wound, which takes place under a too complete conjunctival covering, presents very decided disadvantages to set against the advantage already claimed (namely, the value of this separation as a safeguard against secondary glaucoma). They are (*a*) the permanent astigmatism attributable to it, occasionally considerable in amount; (*b*) some slight fear of accident to such of these eyes as pass through a prolonged low-tension period; and (*c*) the very occasional late, gradual incarceration or prolapse of iris in a wound gaping under the conjunctival flap, seen by us especially after combined extraction. This occurrence is, however, too infrequent, even with a very extensive conjunctival flap, to greatly qualify the statement above made on the use of the flap as a preventive of prolapse. Moreover, this late prolapse, always small, is removable without any particular risk or difficulty. And all of these drawbacks apply only to a covering left considerably larger than usually necessary. They can be avoided by trimming the flap, except where vitreous presenting in the wound renders this inadvisable. (5) Very rarely the flap fails in its purpose through becoming folded down over the cornea.

The question of the **Size** of the wound is not one of importance nowadays. With the application of such

antiseptic and aseptic precautions as are now in vogue, it is found that with a flap not exceeding a semicircle the tissues are sufficiently well nourished to guard against the possibilities of sloughing or suppuration of the flap. The form of the section may also be taken as finally settled for routine extraction.

The most suitable Site of the incision with relation to the corneal circumference, however, is still not finally settled.

The reduced liability to suppuration of sclero-corneal wounds as compared with purely corneal ones was seen in the improved results obtained in pre-antiseptic days with Jacobson's and von Graefe's incisions. The superficial vascular, scleral and conjunctival tissues serve to protect the underlying cornea from bacterial invasion. The resistance of the limbus and of the cornea immediately underlying it is also well recognized in destructive suppurative processes. (Though the protected marginal zone of cornea generally includes a rim of tissue within the normal limbus, this appears to be due to rapid ingrowth of the limbus blood-vessels, rather than to an influence exerted beyond the terminations of the blood-vessels. The rim of cornea saved is found covered at the time with new vessels. Our knowledge of acute suppurations of the cornea, therefore, does not warrant us in expecting the same protection to be afforded by the limbus covering, in the case of a section at the edge of the clear cornea, as when both lips of the incision lie a little further back.) The comparative safety of sclero-corneal wounds is probably explained, not only by their vascularity—which enables them to dispose of bacteria lying in them and also leads to quicker healing—but also by the usual absence of the superficial groove which is formed by retraction of Bowman's membrane in purely corneal

sections. More important than this is the protection of the conjunctival flap.

A minor advantage of a peripheral puncture and counter-puncture is the lengthening of the base line of the flap, enabling the lens to escape more easily. But this is more than counterbalanced by an increased liability to cutting and scraping of the iris by the knife, and by frequent trouble with hæmorrhage during operation. (The tendency to bleeding, however, is a very minor drawback, since it can be prevented by the use of adrenalin beforehand.) A more definite disadvantage is the increased risk of subsequent prolapse.

By a section placed more anteriorly, in clear cornea, trouble with the iris is more commonly avoidable—both accidental section and prolapse. Hence the advantage of such a section in the simple operation. And there can be no trouble from bleeding. But few surgeons care to place any portion of the incision definitely within the boundary of clear cornea, on account of the infective risks. Also the post-operative astigmatism tends to be greater the nearer the incision to the centre of the cornea (though the average amount from a purely corneal section is probably less than that from a sclero-corneal section gaping under a large conjunctival flap). And any adhesion of iris or capsule to the line of the wound appears the more likely to lead to secondary glaucoma the further forward the incision is made.

Smith of Jullundur appears to derive some advantage from an upper corneal section ending well below the corneal circumference, in that he is able to deliver the lens more easily without requiring the patient to look down.

The fairly general selection of the site at the margin of clear cornea has been in the hope of retaining the

benefits of the purely corneal section, and at the same time securing some, if not all, of the safety pertaining to more peripheral incisions. This question of safety from infective risks overshadows all others. If it can be shown that infective complications may be as completely excluded as by the sclero-corneal incision, the placing of the puncture and counter-puncture in the boundary of clear cornea is more than justified. For it is still quite easy to outline a conjunctival flap above. In some eyes this necessitates turning the edge of the knife somewhat backwards in completing the section, but in other eyes (see p. 64) the knife in cutting up parallel to the iris becomes placed behind the conjunctiva above. But it has yet to be shown that infection can be certainly excluded with such a section. In Bombay we have been able to exclude suppurations entirely with our sclero-corneal section, both those beginning in the cornea and those beginning as severe irido-cyclitis. It is to be noted that we did not entirely escape irido-cyclitis ending in sympathetic loss of the fellow eye. We had reason to think, however, that finally this possibility had been practically excluded. And there is no doubt the cases observed were due largely to neglect after operation. The question is of importance here, because in old days it was found that the reduction of corneal wound suppurations by the adoption of von Graefe's peripheral linear section was counterbalanced by an increase of losses from deep infective inflammations ending sometimes in sympathetic ophthalmia. But there is little doubt that these losses were mainly, if not entirely, attributable to the frequent incarcerations of iris in the very peripheral wounds.

The **Downward Section** was practically the only one available for the early operations without anæsthesia.

Neither speculum nor fixation forceps was needed, and the whole operation was less painful and less trying to the patient. The lens and cortical remains were comparatively easily expressed, and the manipulation of the various instruments could be carried out conveniently without much exposure of the eyeball.

The ordinary lower section, however, has serious drawbacks. The risk of infection is increased by the danger of accidental contact of the wound with the lower lid margin in movements of the eye during operation, and by the position of the wound opposite the lid space afterwards. According to our Bombay experience there is a greater tendency to loss of vitreous, from two causes. The wound in this situation is (1) more easily forced open by contraction of the lids, and (2) also liable to be pulled open by the drag of the lower fornix, fixed by the speculum, when the globe rolls far upwards. (The lower fornix, normally less extensive than the upper, was also in our cases frequently more or less retracted by scarring). These dangers, however, can be guarded against by extracting the lens subconjunctivally, and by substituting retractor and finger depression for the speculum. But still the great drawback of all lower sections remains—viz., the placing of the coloboma below whenever an iridectomy has to be made, whether of deliberate intent, or on account of trouble during the operation, or of prolapse afterwards. It was on this account that the upward section became the routine practice for all ordinary cases. It has been held that all the manipulations, including the delivery of the lens, are more difficult by the upper section. But this is not so, provided the patient looks steadily downwards. On the contrary, to one used to the upper section, the delivery of the lens is often less easy through the lower opening. The forceps cannot be

used as mentioned on p. 115, and it is more difficult to cut a satisfactory conjunctival flap below the cornea with the knife. It is a question whether at least a narrow conjunctival bridge should not always be left undivided in operating below, and peripheral iridectomy has special claims (see later).

It has been held that the upper section exposes the interior of the eye more to possibilities of infection, in that not only blood, but also fluids from the surface of the globe, possibly microbe-containing, more easily find their way into the anterior chamber. On the other hand, should irrigation of the chamber be practised for the removal of cortex, blood, etc., the situation of the wound above is undoubtedly preferable. For it is scarcely possible to irrigate without forming a pool of fluid in the conjunctival sac sufficiently large to cover a lower section, thus connecting the interior of the eye by moving currents of fluid with a possibly foul lower fornix.

Some form of downward section is almost forced on one in the case of patients who cannot be depended upon to look steadily downwards. It is also indicated when a coloboma already exists below, either congenital or otherwise; also for lenses dislocated into the anterior chamber; and is performed by some operators where the upward section is difficult in deeply sunken eyes, or in eyes with narrow palpebral aperture. Also, by Czermak's method, for dislocated lenses.

Outer Sections.—Section of the outer portion of the cornea, though largely practised for the 'linear extraction' of soft cataracts, has never become an established procedure for the removal of lenses with hard nuclei. It has been performed, however, by a few operators. Daviel gave a trial to a triangular section outwards. Galezowski (1871) performed von Graefe's scleral linear extraction outwards with a bent knife. Macnamara (1871), Castorani (1874) and Andrew (1883), all

made a linear section at the temporal margin of the cornea with a broad keratome (Castorani later with Beer's knife) and removed the lens in its capsule with a spoon.

*Bourgeois** (Rheims) has reported four perfectly successful simple extractions by an external lateral section specially adapted for the application of sutures. It is designed for occasional use only—viz., in most of the cases where the application of sutures is indicated (p. 214), also in very prominent eyes, and where the palpebral aperture is small, and in totally deaf patients.

He uses a double knife† consisting of two bent "broad needles" lying parallel to one another in the same plane, separated by a space of 1 millimetre. Their handles are locked together by a simple mechanism, which admits of their being easily separated.

Cocain having been freely instilled and Panas' speculum inserted, the globe is fixed at the inner side by the assistant. The puncture is made at the limbus, one blade on either side of the horizontal corneal meridian. The knife is held in the right hand, and this determines the position of the operator for either eye in the usual way. At the moment of puncture the surgeon fixes the eye with his left hand, giving up the forceps again to the assistant immediately afterwards. As soon as the blades have penetrated well into the anterior chamber they are unlocked. And while the lower blade is held in position with one hand, the other one is made to cut upwards along the corneal margin nearly to the vertical meridian. It is then withdrawn, and a similar downward incision made with the lower blade. Thus two equal half sections are made, separated by a bridge of undivided cornea, 1 millimetre broad.

The sutures are now inserted, first one at the middle of the lower half section, and then one in the corresponding position above. In each case the corneal lip of the wound is pierced and the curved needle drawn completely through, before the scleral lip is perforated. The loops of thread crossing the wound are left long, and turned out of the way, upward and downward, over pads of sterilized gauze.

The corneal bridge is then divided with a blunt-pointed knife. The lens is extracted in the ordinary way after opening

* *Ann. d'Ocul.*, cxxv (1901), 10.

† Made by M. Major, 91 Boulevard Saint-Germain.

the capsule, or it may be removed in its capsule with a small spoon. To facilitate this latter, Bourgeois suggests division of the pupillary zone of the iris, where necessary, with scissors. The threads are then drawn tight by their scleral ends and tied. They are left *in situ* for five or six days. A third suture might be placed at the middle of the wound, if thought necessary, to prevent prolapse of iris.

Double Flap Sections.—Schulek* in 1895, and Plehn† in 1901, published accounts of two very similar double-flap sections, designed with the idea of preventing prolapse of iris. The former used a very narrow Graefe's knife, the latter a special trapeziform instrument. After cutting upwards in the limbus

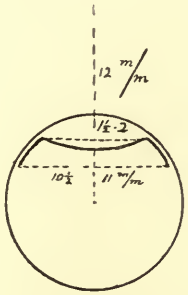

Fig. 76.—Schulek's Incision.

for a portion of the distance for an ordinary upper flap, the section is continued at an angle downwards and forwards to completion. Thus, in addition to a larger lower flap directed upwards, there is formed a smaller overlapping tongue of cornea projecting downwards from above. The lower flap fits into the groove behind the upper, and is kept in place by it. In Schulek's hands the method did not prove effective against prolapse; his proportion was 10 per cent.

L. Müller‡ has designed a section which, by its devious course and by fixation with sutures, provides for very firm and exact closure of the wound. It is intended to be used only in cases where the application of sutures is indicated (p. 214).

The first step is the formation of a small superficial corneal flap with its base upwards at the limbus. Its lateral measure-

* *Ungar. Beitr. z. A.*, i (1895), 254.
† *Zeitsch. f. A.*, v (1901), 259.
‡ *Kl. Mbl. f. A.*, xli (1903), 11.

ment is 5 millimetres, its vertical extent 2 millimetres. It is made by thrusting a very narrow Graefe's knife across in the substance of the cornea, with the cutting edge downwards, and without going deep enough to enter the anterior chamber. After cutting downwards for 2 millimetres, the edge of the blade is turned directly forwards. Thus the small flap, (*a*) (*b*) (*c*) (*d*) and (*i*) (*h*) (*g*), is not thinned at its extremity, but is cut rectangularly.

Two sutures are now inserted through the angles of the flap at (*c*) and (*d*) into the neighbouring cornea, but the loops are left loose.

The section is then completed by an upward incision with a

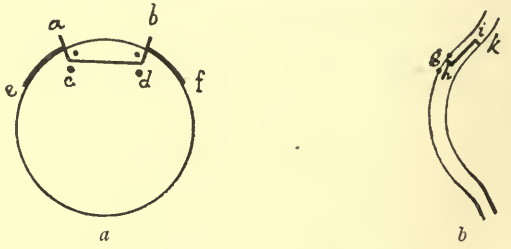

FIG. 77.—L. MÜLLER'S INCISION.

Graefe's knife, as in making an ordinary 3-millimetre corneal flap section. [Puncture and counter-puncture at (*e*) and (*f*), summit of the flap at (*k*) (*i*).] It must end, therefore, exactly at the base of the small superficial flap, and care must be taken not to cut into the base of the small flap at all.

The sutures are tied at the close of the operation, and are not required for longer than one or two days, owing to the considerable area of the opposed surfaces of the wound.

Subconjunctival Extraction.

Where there appears to be any particular advantage to be gained by it, the lens may be delivered beneath the conjunctiva, previously undermined, and thence through an opening which does not correspond with the sclero-corneal section. There are two methods which have been largely practised by a few operators as routine procedure

for the general run of cases. The 'conjunctival bridge' or 'adherent conjunctival flap' operation, first performed with downward section by Desmarres in 1851, was exploited largely with upward section in 1899 by Pansier and Vacher (Orleans), independently of each other. The method is as in the cutting of a large conjunctival flap, but the knife is passed onwards under the conjunctiva for 1 to 1·5 cubic millimetres, and the making of the flap is not completed, a bridge as broad as possible, 5 to 8 millimetres, being left undivided. From this simple measure Czermak's 'conjunctival pouch' operation developed, affording an even more effective covering to the deep wound. The first step was the preliminary undermining of the conjunctiva with scissors before making the section. And finally, the sclero-corneal section itself was made mainly with scissors subconjunctivally.

The main value of the subconjunctival operations obtains during the healing period. The more complete the covering of the sclero-corneal wound, the more perfectly is secondary *infection* excluded. By Czermak's method the protection appears complete. As a safeguard, however, against primary infection—*i.e.*, infection introduced during the operation—the advantage of the subconjunctival methods of extraction is not so definite. The deep wound is certainly guarded from accidental contact with palpebral conjunctiva and lid margins (and from fouling by the operator's saliva should he not wear a mask), but otherwise the possibilities as regards the entry of micro-organisms do not appear greatly altered.

The conjunctival covering is not able to retract like a completely divided flap, and so there is not the subsequent separation of the deep wound which forms one of the drawbacks to a large flap, and its rapid union with the underlying tissue serves to prevent reopening of the wound

and *prolapse of iris*. Czermak found the eye practically safe from iris prolapse after the first few hours following operation. Vacher reported a series of 120 extractions, mostly simple, free from prolapse. In our Bombay experience of Czermak's operation we had almost no prolapse, though the pupil was sometimes left somewhat distorted and displaced. Against this, however, must be set the frequency with which we had to perform combined extraction (see below). Should prolapse occur, it does not open a way for infection of the eye, owing to the protrusion being subconjunctival.

It is a small advantage that the eyes thus operated upon need less after-care than ordinary, also it is claimed that there is less astigmatism caused.

The tense conjunctival covering is of service during the operation in certain cases (p. 211), in reducing the risk of vitreous accident.

The *drawbacks* to any subconjunctival operation are chiefly:

1. Undoubtedly an enhanced difficulty at times in delivering the lens safely, and in evacuating lens remnants. The difficulty is, perhaps, greater the more the conjunctiva is anchored, as it is in the 'pouch' method, and where the 'bridge' is very broad. Hence frequently injury to the iris necessitating iridectomy, and a temptation to increase the pressure in expulsion, to such a degree as to risk rupture of the zonule.

The iridectomy is of consequence only in the downward-placed operations. In our earlier operations with conjunctival pouch — doubtless owing largely to faulty technique—we had to do combined extraction in about half the cases, and only quite at the end did we reduce the proportion of combined operations much below one-third. In 110 Czermak's operations an iridectomy was made no

less than 46 times, and once excision of prolapse was undertaken afterwards. The *coloboma,** *situated downwards and outwards*, constitutes a grave defect in a patient who requires very acute vision afterwards.

2. The number of vitreous accidents attributable to difficult expulsion of the lens is likely, unless great patience be exercised in the expulsion, to obscure the advantage of the operation in this respect in the special cases above referred to. In Bombay our proportion of vitreous losses was slightly higher in these operations than in ordinary extractions.

3. The tendency to stripping of cortex in the delivery of the lens through a wound not widely open renders subconjunctival extraction quite *unsuited for* cataracts at all *unripe*.

4. In spite of adrenalin, *hæmorrhage* into the anterior chamber may occasionally cover lens and iris. A small quantity of blood may be readily expressed. But persistent bleeding† from rigid blood-vessels may fill the chamber and the conjunctival pocket (in Czermak's operation) with clot, rendering the completion of the operation

* In most of our Indian patients the iridectomy downwards could not be considered a very serious drawback. In some instances the excision of iris was to facilitate the delivery of the lens or of lens remnants; in others to prevent prolapse of the iris, more or less injured in the expulsion of the lens. In most of these latter cases the complete coloboma might probably have been replaced by a small peripheral opening, with little or no effect upon vision. Such a small iridectomy might be made downwards or downwards and inwards through a small conjunctival slit.

† In one of our cases, already mentioned on p. 162, there was bleeding about the close of the operation to produce a considerable swelling under the conjunctiva with separation of the lips of the deep wound and bending forward of the lower part of the cornea. There was no pain, and no loss of perception of light. But the pupil became closed with clot and lymph, and though the iris was perfectly clear, needlings failed to provide an open pupil, and the tension of the eye remained low.

very difficult, and making it impossible to deal satisfactorily with the iris.

5. The slight prolongation of the operative procedure is scarcely noticeable in the narrow bridge operation, but is definite where undermining of the conjunctiva by scissors is undertaken. This is of no importance in downward sections, but appears to limit the application of Czermak's upward section very considerably, owing to the increased strain placed upon the patient's self-control in continuously looking downward.

Czermak's Downward Section with Subconjunctival Pouch.

Adrenalin must be combined with the cocain or used before it, and during this operation the cornea needs moistening from time to time with sterile salt solution. The operator stands in the usual position for the right eye, beside the patient for the left eye. The patient turns the eye somewhat upward, and the globe is fixed with forceps close to the inner side of the cornea, immediately above its horizontal meridian. With a broad (3-millimetre) Graefe's knife a sclero-corneal puncture is made close to the limbus at the outer end of the horizontal corneal meridian, with the cutting edge of the knife downwards, as if to cut a semicircular flap with the knife. The puncture is made subconjunctivally after engaging the conjunctiva at a little distance (2 millimetres) from the cornea on the point of the knife and sliding it inwards. The capsulotomy may, if preferred, be made with the point of the knife, and the instrument is then withdrawn. Or the capsular opening may be made later in the usual way.

The opening in the conjunctiva is then extended with

scissors obliquely down and out, nearly to the lower fornix. The inner border of this slit is now raised with forceps and the scissors introduced, to undermine by a few snips the lower ocular conjunctiva from the limbus down-

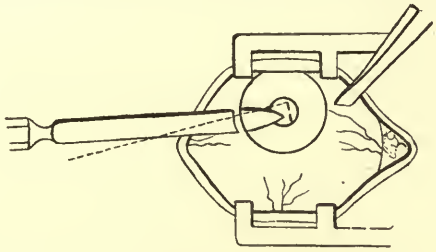

FIG. 78.—CZERMAK'S LOWER SECTION.
The Puncture.
(*From 'Die Augenärztlichen Operationen.'*)

wards. Thus is formed a subconjunctival pocket, as far as a vertical line falling from the inner end of the horizontal corneal meridian. Czermak holds it important to loosen the membrane quite up to the limbus, to enable

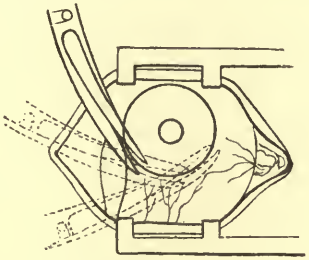

FIG. 79.—CZERMAK'S LOWER SECTION.
The Cutting.
(*From 'Die Augenärztlichen Operationen.'*)

the sclero-corneal section to be placed immediately behind the limbus, thus to reduce the chances of prolapse and incarceration of iris. At the same time care must be taken to avoid perforating the conjunctiva with the scissor points.

The sclero-corneal section is now completed with scissors. Czermak uses Louis' scissors, with fine and thin blades, curved on the flat, and with round points. One blade is 1 to 1·5 millimetres longer than the other. Therefore two pairs of these scissors are required, one for the right eye and one for the left. The long blade is introduced into the anterior chamber through the puncture, and the other blade passed under the conjunctiva. With three or four snips a subconjunctival incision may be made as far as the nasal end of the horizontal meridian of the cornea. In cutting, the scissors are held obliquely to the scleral surface, so that the curvature of the blades may correspond with that of the corneal margin, and a light forward pull upon the eye is maintained by the deep blade. The little finger of the cutting hand is supported on the assistant's hand, except at the beginning of the incision in the right eye, when it rests against the patient's temple.

The lens is delivered in the ordinary manner of simple extraction by pressure above and counter-pressure below. The spatula or curette below is introduced under the conjunctiva. The lens is pressed into the subconjunctival pocket, and thence outwards. Any cortical remains are dealt with in the same way, or removed by irrigation.

The iris frequently becomes prolapsed, and in any case needs to be replaced with the spatula if the pupil is not round.

A fine suture may now be used to close the conjunctival opening (I have never sutured it), and finally eserin is instilled.

To remove the danger of primary infection during the operation as completely as possible, Czermak was careful not to introduce any instrument into the eye nor to raise the lip of the conjunctival opening without first mopping up any trace of

fluid which might be lying in the lower fornix. The mouth of the pocket was opened with fine forceps at the time of introduction of any instrument, in order that the latter might not come unnecessarily in contact with the conjunctival surface.

A small modification of the section is to make not only the puncture, but also the counter-puncture with the knife, and so to get over the difficulty which is experienced in cutting with the scissors at the nasal end of the incision if the patient does not look upwards. The perforation of the conjunctiva, however, leaves the sclero-corneal wound not quite fully covered.

In our Bombay operations by this method I nearly always punctured a little above the horizontal meridian of the cornea, with the knife pointing upwards and inwards, and so made the flap downwards and a little outwards instead of directly downwards. This, of course, reduces the difficulty in cutting with the scissors at the inner side. Even so, with a patient who is unable to fix his eye at all upwards, it is well to counter-puncture with the knife. If this counter-puncture be made slowly about $\frac{1}{2}$ millimetre behind the corneal margin, and especially if the blade be twisted slightly at the time, leakage of aqueous under the conjunctiva may balloon it forwards out of reach of the point of the knife, so preventing any perforation of the conjunctiva. It saves trouble, also, to cut the greater portion of the temporal half of the deep wound by sawing movements with the knife. The section, as far as the vertical meridian of the cornea, may be readily made thus with an empty anterior chamber and without injury to the iris or to the conjunctiva, if the simple precaution be taken to do all the actual cutting in the withdrawal movements of the knife (none during the inward movements of the blade). In one case I made the whole of the section, including the counter-puncture, subconjunctivally with the knife.

Our difficulties in expression were lightened as soon as we realized that it was better to remove the stop-speculum and to substitute Desmarres' retractor for the upper lid and finger depression for the lower lid, before attempting to expel the lens. This loosens the conjunctiva considerably.

Finding it easier to express (by means of the tenotomy hook) with the right hand and to apply counter-pressure (by the curette) with the left hand, I had to change position always

from the patient's head to his side, or *vice versâ*, after making the section.

Our troubles in the earlier cases were sometimes due to making the section rather small. I used only Stevens' curved strabismus scissors—one pair for cutting and loosening the conjunctiva, and a second pair for the deep section. (Being rather stiff in opening, they had usually to be withdrawn from the wound between the snips.) In cutting, the scissors were steadied against the left forefinger. The scissor blades nearly always got soiled by contact with the lid margins, but not close to their points.

The deep wound may become exposed in part owing to perforation of the conjunctiva. This may happen either in undermining the membrane close to the limbus, or during the making of the section if any downward movement of the eye should then take place, or if the scissor blades be not held at the correct angle of obliquity.

In one or two of our cases the base of the iris was nipped by the scissors. The weakening or perforation of the base of the iris increased the difficulty of forcing the lens through the pupil, and so perhaps accounted for a few of our iridectomies.

Among the minor drawbacks and complications of the operation may be mentioned also:

Like all downward sections, the wound is badly situated for irrigation of the anterior chamber, for it is impossible to use the ordinary irrigator without forming a pool of fluid in the conjunctival sac covering the wound. The surface of the conjunctiva must, therefore, be well douched before any fluid is allowed to enter the wound.

After operation, transient patchy opacity of the centre of the cornea in its posterior layers, extending frequently by streaks to the wound line, afforded evidence of bruising of the centre of the cornea during the expression of the lens. Its flaky appearance gave a close resemblance to bits of lens cortex left in the anterior chamber. Finally, at the time of discharge the fine posterior lines mentioned under 'Corneal Opacity,' Chapter V, were frequently found, especially following early cloudy opacity, extending more or less over the central area of the cornea.

At the time of discharge a number of eyes were found still very soft, though there was no visible separation of the deep

wound. The sclero-corneal wound surfaces made by the scissors appear, therefore, frequently slow in uniting. We kept one of these patients in hospital for three weeks after operation, and still the tension was very low.

Indications.—A. Where a complete covering appears advisable or imperative to *keep out infection.*

1. In Bombay the operation was mostly performed from fear of infection from an unhealthy conjunctiva, discharging slightly. Danger from any slight inflammation about the lids might be similarly guarded against. If the fellow eye had been lost by suppuration following cataract extraction, the subconjunctival method would seem to be indicated.

2. Very unhealthy patients need all the protection they can get, on the supposition that their tissues cannot be expected to cope with even very few and but feebly pathogenic micro-organisms. This applies particularly to albuminurics with marked anæmia and some œdema about the ankles.

3. In rare cases where prolapse or loss of vitreous seems likely to occur, preventing immediate closure of the wound, it is well that the wound shall be covered as completely as possible. This applies for a lens dislocated into the anterior chamber. For such a lens the operation is also indicated, on account of the position of the wound, and the mode of making of it with scissors. These claims hold in spite of the possible drawback of having to make a coloboma in the iris downwards. But I think Czermak was wrong in advising this method for partially dislocated and tremulous lenses, because in such eyes the utmost gentleness and freedom of manipulation are demanded in extracting the lens.

B. To *reduce the risk of vitreous loss* during operation.

Nervous, frightened patients, who jerk their eyes about on small provocation, and are thus very liable to accident

under the ordinary operation, behave remarkably well during Czermak's operation. This is largely owing to the degree of anæsthesia induced by the combination of adrenalin and cocain. Their quietude is further assured, in that they are not worried with instructions to keep their eyes strongly rotated in any direction.

Further, the wound cannot well be forced open by spasmodic closure of the lids, nor can it be pulled open by extreme vertical movements of the globe. This advantage is greatest in exophthalmos and where the fornices are much retracted by scarring. In tremor capitis and marked nystagmus this operation is the safer.

C. Czermak's operation may well become *almost the only downward section* practised, as it is distinctly superior to the ordinary lower section. In Bombay we used the method in stupid patients who were unable to look steadily downwards after a little training, and we were thus saved much worry. In very deaf patients the same would apply. In other conditions which call for the lower operation, such as the presence of a coloboma below, congenital or manufactured, Czermak's method is suitable. It may, however, be impracticable, owing to adherent leucoma or anterior synechia, or in rare cases of scarring of the ocular conjunctiva, from injury or otherwise. In patients in a state of dementia the method appears advisable on grounds both B and C, also on account of the lightened after-care.

D. A very occasional indication for the scissor section is where during the ordinary operation the anterior chamber becomes emptied accidentally soon after the puncture has been made. The puncture being above the horizontal corneal meridian, Czermak would have completed the operation upwards with iridectomy. But unless iridectomy seems likely to be called for, a section down-

wards and outwards is applicable, especially in patients who cannot be expected to maintain prolonged downward fixation.

Czermak also made a similar upward section in eyes where iridectomy was likely to be needed. The piece of iris was removed through a minute vertical conjunctival puncture.* As already mentioned, the great objection to this operation is that the long period of downward fixation required would appear to place a considerable strain upon the patient's self-control. In this important respect it presents a great contrast with the downward scissor section, which is comparatively easy of performance, and does not need the co-operation of the patient at all.

When a tense covering is desired for an upward section, as in an eye, glaucomatous or otherwise, where vitreous tension probably exists, or where there is persistent cough, dyspnœa, or straining in micturition, the necessary conjunctival bridge can be fashioned sufficiently well and quickly with the knife. Should a very complete covering be desired, the site of the puncture may be covered by sliding the conjunctiva, and that of the counter-puncture by bringing the point of the knife out a fraction of a millimetre further away from the corneal margin than usual (p. 79). Thus, the 'bridge' will probably usually replace the 'pouch' above the cornea. Below the cornea a conjunctival bridge may still occasionally be made where for any reason the scissor section of the sclera and cornea is inapplicable.

Kuhnt has employed a double-pedicled band of conjunctiva for covering the cataract incision, outlined and undermined beforehand. The two attached ends are situated laterally. It has been used as a prophylactic against infection in unruly patients and in those suffering from emphysema, bronchiectasis, ozæna, chronic rhinitis, etc.

Wound Suture.—Suturing the wound, first used in cataract extraction by Williams† (Boston) in 1867, has been tried by various operators. The sutures, at first applied at the close of

* Liebreich's iris forceps were used, in order not to stretch the small conjunctival opening.

† *Congrès de Londres: Compte rendu*, 1873, p. 174.

the operation, were inserted by Czermak immediately after making the section. Suarez de Mendoza* made an incision at the limbus only two-thirds or three-quarters through the cornea from the anterior surface, and then applied the sutures before opening the anterior chamber. Bourgeois, using a special double-bladed knife, is able to leave a minute central bridge of tissue undivided till after the threads are inserted. L. Müller, in a complicated incision, inserts the sutures before the anterior chamber is opened. Kalt† and others applied them before beginning the section. They have been employed either (1) as a routine procedure, to guard against prolapse of iris more particularly; or (2) in selected cases only, where there was reason to fear loss of vitreous or displacement of the corneal flap or expulsive hæmorrhage; or (3) later, in the healing period, to bring together wound margins separated by extensive prolapse of iris or vitreous, or by anteflexion of the cornea. I have had personal experience of the corneal suture only in certain glaucoma operations. As applied to the ordinary upper cataract incision it is altogether too difficult and complicated a measure, placing too great a strain upon the patient for general use. Its application to a lower or outer section is simpler and easier. But it has to compete, as regards both usefulness and safety, with other measures, more particularly subconjunctival extraction.

As a preventive of prolapse a single suture has not proved always successful. Kalt had four prolapses in fifty operations, Czermak two prolapses in ten cases, Schweigger six prolapses in twenty-seven operations. As a safeguard against secondary infection, the sutures, though not going through the whole thickness of the cornea, and therefore not entering the anterior chamber, are perhaps not altogether free from suspicion.

But sutures should perhaps serve best to keep the wound firmly closed after operation. They may thus prevent vitreous prolapse in patients of feeble intelligence, or when delirium is feared (*e.g.*, in drunkards), or in very old people who cannot be kept recumbent, or after operation for luxated or subluxated or tremulous lenses, or in glaucomatous eyes and eyes with vitreous tension, or where there is severe bronchitis, asthma, etc., or where the fellow eye has been lost by expulsive

* *Arch. d'Opht.*, ix (1889), 444.
† *A.f. A.*, xxx (1895), 15.

hæmorrhage. Apparently vitreous presenting in the open wound at the close of the operation may sometimes be made to recede without any of it being lost by the tightening of the sutures. Kuhnt has spoken well of suturing in special cases. During operation, however, there is no help to be got from sutures as there is sometimes from the subconjunctival method of operating—*e g.*, in the case of unruly patients in whom blepharospasm and movements of the globe are to be feared. The simplest way of obtaining double traction across the wound is to pass the fine, sharp, and curved needle and thread horizontally about 3 millimetres in the cornea and back again in the sclerotic. The loop of thread lying across the proposed line of incision—left long during the making of the section and the completion of the operation, and kept as clean as possible by resting on a sterile pad of wool—forms one band across the wound when tightened up, and the ends of the thread tied together form the second.

FIG. 80.—WOUND SUTURE.

Sutures have been applied, also, *to the conjunctival flap* by Williams (Boston), Kuhnt, Maddox, and others. Williams in eleven cases had one prolapse.* Komoto (Japan) has fixed a long conjunctival flap by means of a suture passed through the tendon of the superior rectus.

Ellett† (Memphis), to guard against infection in a case of intractable chronic conjunctivitis, separated the conjunctiva around the whole of the cornea before operation, as for enucleation. Afterwards he drew the edges of the conjunctiva together over the cornea with sutures horizontally placed. The stitches were removed after four days. Three days later the conjunctiva had retracted to its normal position. The case did well, though the conjunctival discharge persisted.

* *Boston Med. and Surg. Journal*, April 16, 1896.
† *Ophth. Record*, 1903.

SIMPLE EXTRACTION.

No question in eye surgery has been more discussed than the merits and defects of the two methods of operating, with and without iridectomy. Opinions have varied much, and apart from preconceived ideas practice has been influenced by the conditions of operating, the quality of the nursing, and the skill and experience of the surgeon and of his assistant.

Not only has each method of operating—the combined and the simple—claimed strong partisans, but the opinions of individual operators have veered from one extreme to the other with their varying experience. One's attitude in the matter is doubtless largely controlled by temperament. Most beginners rightly practice the combined method exclusively, and many experienced operators have been content to continue throughout with the more certain attainment of thoroughly useful results. Whereas others, desiring the best attainable, have not been deterred by occasional accidents from aiming at the ideal. Most surgeons nowadays recognize that this unsettled question, like practically all others in cataract work, is one for the exercise of eclectic principles. Each of the two operations may claim an indisputable field of applicability, but the boundary line between them must ever be a very loose one. The question is no longer, Which is the better method? But rather, In which cases should the simple operation be attempted? Selection of cases is needed for simple extraction, since some only are suitable, whereas all senile operable cataracts are alike fit for the combined operation.

Differences of opinion hinge largely on the varying appreciation of the value of the round mobile pupil obtained, when all goes well, by simple extraction. Most

of the patients are too old to care much about the disfigurement of the coloboma of the combined operation. This may, indeed, be scarcely noticeable in dark eyes, or may be covered by the upper lid if the palpebral aperture be rather narrow. It has never been shown that the visual acuteness of the eye, as corrected by glasses, is at all impaired by the addition of the coloboma to the pupillary area, and by the accompanying enlargement and sluggishness of the pupil. Increased frequency and degree of some minor visual defects must be admitted as due to iridectomy, but mainly to a wide iridectomy. Exposure to strong sunlight has in some cases caused much disablement from dazzling, even though the visual acuteness was good. It has also been responsible for retinal exhaustion and erythropsia. Another disadvantage of a wide coloboma acknowledged by von Graefe, is defective orientation from poor peripheral vision. On the whole, the gain from a small active pupil is too slight to justify any large risks or sacrifices.

The penalties incurred by the simple method are seen in the complications met with—prolapse of iris and trouble with lens cortex. The weak point of the operation is universally admitted to be the tendency to iris prolapse with all its attendant evils, iritis, irido-cyclitis, sympathetic ophthalmia, cystoid scar, staphyloma, and astigmatism. A prolapse rate of 5 to 10 per cent. is a serious matter, considering that the protrusion of simple extraction is often too large to be completely excised. In spite of treatment, incarceration of the iris in the scar may be left with its permanent drawbacks and dangers. In the combined operation entanglement of the iris in the wound is much more regularly preventable. And the inclusions, besides being less frequent, are smaller; they are mere incarcerations and small prolapses. It seems strange that

these small entanglements (of divided iris) have been blamed more* as excitants of destructive irido-cyclitis and sympathetic ophthalmia than have the larger protrusions (of the unwounded, uninjured iris) of the simple method.

Is it not simply that incarcerations are often left untreated, to give rise to infection, while prolapses more insistently demand excision? Our Bombay experience, indeed, led us to regard the small entanglements of combined extraction as distinctly less prone to excite iritis and irido-cyclitis than the large prolapses of the rival method. And it was thought that this difference was due to the fact that the small inclusions were more often completely covered by the conjunctival flap than the larger ones. And our operative experience in the treatment of glaucoma warranted us in anticipating a very considerable permanent protection from this conjunctival covering.

The operation without iridectomy is almost free from risk of impaction of capsule in the wound, an accident possibly quite as harmful as impaction of the iris. But this is a comparatively rare complication in a properly performed extraction with iridectomy.

Judging from our Bombay experience, too much has been made of the liability of impactions and adhesions of iris and of capsule to give rise to glaucoma† after the combined operation. In this respect we found little cause to fear either obvious incarcerations of iris, or the adhesions of one or both pillars of the coloboma to the line of the wound, almost constantly met with. The drawing forward of the iris by these frequent minute adhesions to the peripherally situated scar must be generally almost inappreciable. Though the combined operation is the more fre-

* *E.g.*, by de Wecker, *Ann. d'Ocul.*, xciv (1885), 29.
† See Chapter V.

quently followed by glaucoma, this can be reckoned but a comparatively small drawback compared with the disadvantage of iris prolapse after simple extraction. For secondary glaucoma is always uncommon; in Bombay, so far as we could tell, it was quite rare, for the reason already given.

In extraction without iridectomy cortex is more often left in the eye, especially behind the upper part of the iris, in spite, perhaps, of more regular use of irrigation and more prolonged manipulation. It has been held* that this does not apply in patients over fifty-five years of age, when the layer of soft cortex in the lens is thin and comes away readily with the nucleus. But this has not been my experience. Hence sometimes tedious and prolonged after-treatment, controlling iritis, or waiting for the absorption of lens matter. Hence also rather more frequent needling required for after-cataract. Also it must not be forgotten that the more frequent need for fairly prolonged irrigation during operation may be counted as a definite drawback in itself. As regards retained cortex and after-cataract, it may be stated that after simple extraction there is more chance of the pupillary area being entirely occupied temporarily by opaque tissue than there would be if the possible visual area were enlarged by the addition of a coloboma. But after needling, the advantage more often lies on the other side. An entirely black pupil is more probable the smaller its area. With a large coloboma the vision may be a little reduced by diffusion of light through grey patches beside the clear area.

Owing to the risk of these complications, iris prolapse and cortex remaining behind, the results of simple extraction are admittedly less certain than of the combined operation. Though the percentage results may work out

* *Cf.* Czermak, 'Die Augenärztlichen Operationen,' S. 973.

as well for the former as for the latter, the comparison must take into account the selection of cases. The cases least favourable for operation are relegated to the combined list. The result of such comparison, favourable as it may be to the combined operation, does not, however, necessarily indicate an all-round superiority of the latter. It merely emphasizes the need of careful selection.

Various other advantages and disadvantages, of minor importance or ill substantiated, have been urged for and against each method. The simple operation is held to be the quicker of the two; by some operators the easier, and by opponents more difficult. It is claimed that the operation is simplified by the omission of one step which, by the way, is not infrequently a slightly painful* one. The feeling of the majority—viz., that simple extraction undoubtedly often proves the less simple in performance—is echoed in the general instruction to beginners to confine themselves to the combined method. The difficulty experienced in delivering a firm sharp-edged lens without stretching and bruising the iris, cannot always be avoided by making the regulation incision, including three-sevenths to one half of the corneal circumference. Also there is the trouble with cortex already mentioned.

The larger incision demanded by the simple method cannot nowadays be considered a drawback, except in so far as it predisposes to accidental reopening of the wound and consequent prolapse of iris, sufficiently noted above.

It has been counted as one of the advantages of combined extraction, that it permits of the section including an extensive conjunctival flap, but with care the same section may be used for simple extraction (p. 225). The simple method certainly at times necessitates slightly less instrumentation, and thereby possibly less chance of introducing infection. But the relative incidence of infective inflammations has been connected almost entirely with the scar results already discussed.

Loss of vitreous has been said to follow the simple operation less often than the combined. Drake-Brockman,† comparing

* Bleeding from the cut iris has been mentioned also as a drawback to the combined method. See, however, p. 98.

† *The Ophthalmoscope*, v (1906), 123.

the two methods in equal numbers of cases from his own practice, 293 of each operation, gave percentages of 1·02 and 5·8 vitreous losses. Marshall's Moorfields figures* from 1889-93, showed only a small difference—2·99 per cent. and 3·75 per cent.

The risk of prolapse of iris renders simple extraction seldom applicable for private work in a patient's house unless one is prepared to visit the case next day with an assistant, prepared to excise iris, if necessary. On this account I have scarcely ever adopted the method in private operations. (Czermak's sub-conjunctival operation is almost free from this objection.)

The Selection of Cases.—The cataract must be ripe, or its removal will be incomplete. It must not be very overripe,† with opaque capsule to be extracted.‡ And tremulous and subluxated lenses, also cataracts in eyes with presumptive (in high myopia) or certain disease of vitreous, all demanding the easiest possible delivery of the lens, are excluded. Also usually 'black' cataracts—hyper-sclerotic lenses—too large to pass easily through the pupil. (In general, the older the patient the more often may iridectomy be needed on account of the large size of the lens.)

An iridectomy may be necessitated by a small and rigid pupil,§ or, for optical reasons, by central corneal opacity. For both optical and mechanical reasons by synechiæ, anterior or posterior, it being necessary to provide space

* *R. L. O. H. Rep.*, xiv, 56.

† Morgagnian cataracts, though overripe, are very suitable for simple extraction if they happen to possess transparent or nearly transparent capsules, as they not infrequently do.

‡ The Punjab operators, Mulroney and Smith, extracted lenses in their capsules without iridectomy. But Smith now performs these operations preferably with iridectomy.

§ The rigidity of pupil may have been noticed by very imperfect dilatation in the dark room, and later under the influence of cocain. Otherwise it may not be noticed till an attempt is made to expel the lens, when it may be one of the troubles which transform an intended simple extraction into a combined one.

for the passage of the lens. Glaucoma, primary or secondary, necessitates a wide coloboma. Though this is commonly made beforehand, it need not be always so (Chapter VI), especially in India, where the patients will not usually wait for the two separate operations. Also iridectomy must generally be performed in eyes with very shallow anterior chamber.*

The conjunctiva, and still more the lacrymal passages, must be healthy, so that if prolapse should occur the iris may not be exposed to the attack of pathogenic organisms. The patient must be quiet and sensible, behaving well under the usual tests for lid control and globe fixation. There must be no clonic spasm of the lids, and no general condition present likely to interfere with the healing of the wound. Among such may be mentioned a chronic cough, dyspnœa from any cause, straining at micturition or at stool, also a feeble intellect, epilepsy, extreme old age and extreme obesity. Also there should be no special reason to fear iritis afterwards, as in diabetes or albuminuria.

If the sight of the fellow eye has been lost, the combined operation is nearly always indicated. Outside conditions should be satisfactory—*e.g.*, the surgeon sufficiently experienced (Pagenstecher),† and the nursing good, and there must be no occasion for general anæsthesia.

* These eyes are mostly debarred from the simple operation by the fact that the cataract is seldom quite ripe. There is generally some transparent cortex present. Should this, however, not be the case, simple extraction may be attempted if preferred. That is to say, the larger section of the simple method may be made. Iridectomy then may, or may not, prove necessary on account of injury to the iris by the knife, or through trouble with the copious soft cortex present, or possibly on account of vitreous tension. Should this latter condition chance to be present, the larger wound will prove a distinct disadvantage. My personal preference is for the combined operation, with smaller incision, in all eyes with marked shallowing of the chamber.

† *Kl. M. f. A.*, xxxii (1894), 339.

An operation begun as a simple extraction not infrequently becomes a combined one. This happens most often from over-stretching or bruising of the sphincter of the pupil; also from scraping or wounding of the iris by the knife, or nipping with capsule forceps. Seldom on account of vitreous tension or vitreous prolapse or escape. Sometimes because the lens refuses to rotate forward easily into the pupil (still more should it have become partly dislocated during the opening of the capsule), or because of cortex remaining impacted behind the iris. Or, again, the change may be due to the patient proving unexpectedly deficient in self-control.

It is only rarely that one's intention becomes altered in the reverse way—*i.e.*, that an operation meant to be a combined one is ended without iridectomy. This happens when a considerable early prolapse of vitreous renders iridectomy unnecessary by displacing the iris backwards.

A few years ago the number of simple extractions performed at the C. J. Hospital, Bombay, was about half that of the combined operations (*The Practical Details of Cataract Extraction*, second edition, p. 63). The small proportion was explained by the number of unripe cataracts operated upon, also by the frequently unsatisfactory state of the conjunctiva, and by frequent injury to the iris through using slightly blunted knives, and by the want of proper nursing. Later the proportion fell considerably lower. But quite at the end of my time in Bombay, when the advantages of adrenalin had been realized, simple extractions were becoming more frequent than combined.

The Performance of simple extraction is in principle merely the operation already fully described, minus one important step. In practice differences have to be emphasized at each stage of the operation.

It is a question whether *adrenalin* should not be used regularly with cocain in the eye before simple extraction.

This was our practice in Bombay latterly, having been begun and having proved satisfactory in subconjunctival extractions by Czermak's method. Under the combined influence of the adrenalin and cocain the pupil was found enlarged at the time of operation. The degree of dilatation was at times only moderate, at other times considerable. The pupil was generally not quite round and also somewhat displaced, perhaps most often downwards. The enlargement of the pupil seemed to us particularly helpful, in that it persisted fairly well after the anterior chamber had been opened. The passage of the lens through the pupil without injury to the iris was appreciably facilitated, thus lessening the risk of subsequent prolapse. The value of the adrenalin lasted after the operation. Eserin solution, 4 grains to the ounce, being instilled once or twice (with an interval of one minute) at the close of the operation, its action upon the pupil was enhanced by the localizing influence of the adrenalin. It thus sufficed to overcome the dilatation, and almost invariably next day a quite small pupil was found, guarding against prolapse of the iris. The liability to this complication was also, perhaps, somewhat reduced by the mental quietude of the patient during and after operation, attributable to the more complete anæsthesia.

The *section* must be of full size, including three-sevenths to one-half of the corneal margin, without regard to the nature and size of the cataract. The base of the flap must thus be brought low down, nearly or quite level with the centre of the pupil, in order that free immediate rotation of the lens upon its horizontal axis may be provided for, without preliminary upward sliding of the lens. It is more important also that the knife shall be quite sharp, and the first inward thrust should perhaps be made rather more quickly than in the combined operation,

so that the edge of the knife shall in general reach almost the summit of the anterior chamber in the one movement. It is important that the greater part of the section shall be completed with some aqueous still in the anterior chamber, and that the final sawing action of the knife shall be as restricted as possible. Otherwise the iris must be rubbed and injured by the blade, and this tends greatly to the subsequent occurrence of prolapse.

There is a general feeling that the section should not lie at all behind the superficial sclero-corneal junction, but this admits of dispute. Allowing that proximity of the wound to the base of the iris increases the tendency to prolapse, yet it by no means follows that a sclero-corneal incision should always be accompanied or preceded by an iridectomy. I have always retained the same site for simple as for combined extraction. Much of the tendency to prolapse through a large sclero-corneal wound may be overcome by the early adhesion of a fairly complete conjunctival flap. And we have in general been more careful to provide an effective conjunctival covering than in combined extraction. Perhaps a more effectual additional safeguard is the combination of eserin and adrenalin instillation. And perhaps with this posterior incision one must be more ready to perform iridectomy at the close of the operation, should the pupil be at all distorted and displaced. In Bombay we would have given up simple extraction altogether if its performance, by altering the site of the incision, had necessitated giving up or considerably reducing the conjunctival flap. The conjunctival covering was considered a necessity, and the retention of the intact iris rather a luxury.

Should the iris have been much scraped by the knife, or should a small piece of it have been unintentionally excised, it is better, as a rule, to complete the iridectomy at once before

delivering the lens. Otherwise the margin of the lens, instead of coming forward to the pupil, tends to engage in the weakened area of iris. The intact pupillary band holds the lens back until the band becomes much stretched or broken.

Should iris prolapse immediately after the section has been made, it is replaced by the curette. If a round pupil is not secured at once, it is perhaps well to perform iridectomy.

In performing the *capsulotomy* long incisions are not quite so readily made as when there is a coloboma, hence they more generally need to be multiple. The use of capsule forceps is described later.

Delivery of the Lens and of Cortical Remains.—Steady continuous pressure is applied with the hook or spoon directly backwards about the junction of the middle and lower fourths of the cornea, while counter-pressure is made with the curette placed horizontally above the wound. The hook is held in the right hand and the curette* in the left hand. The primary object is to tilt the upper edge of the lens forward into the pupil. The corneal flap, if its base be sufficiently low, at once swings forward, and with it the lens and upper part of the iris. At the same time some little upward movement of the lens and of its covering iris takes place. The iris stretches, but less so than the pupil, which widens mostly laterally as the lens equator slowly revolves forward to occupy it. As soon as the upper margin of the lens is visible at the upper border of the pupil a slight increase of the pressure of the hook backwards and upwards suffices to bring the lens forward into the chamber and into the gaping wound. The backward pressure of the curette assists in drawing the iris back over the upper margin of the lens. As soon as this

* For use upon the right eye the curette held in the left hand must be fully curved, otherwise it cannot be laid flat above the wound. If the curette be made of German silver, the curve may be readily altered as desired.

upper part of the iris has receded behind the presenting lens, the steady pressure upon the cornea may often be advantageously replaced by repeated short, light, upward pushing strokes over the lower part of the cornea.

These strokes are very effective applied below the lower margin of a firm discoid lens. The lens should thus pass upwards without carrying the iris into the wound, so that when the lens is delivered the wound may close unoccupied by iris. Cataracts with firm cortex, however, and flattened anterior surface and sharp equator, do not come forward easily into the pupil, and upon continued pressure readily slip upwards and carry the iris into the wound. The same trouble frequently occurs with too small a section, *i.e.*, with a section suited for most combined extractions. If the pressure be continued, the sharp edge of the lens stretches the iris considerably, scraping off uveal pigment and weakening the sphincter muscle, before finally entering the pupil,* so that it is better to relinquish for the moment the attempt to express the lens. The curette having been removed and the wound allowed to close, the lens is pushed downwards into position by the convexity of the hook (or spoon) applied to the upper part of the cornea. A second attempt to swing the lens equator forward into the pupil may be then more successful. In general, quicker expression is aimed at than in combined extraction, since only fairly ripe cataracts are operated upon without iridectomy. A rather rapid passage of the lens through the pupil obviates unnecessarily prolonged stretching of the sphincter, and so tends to reduce the risk of subsequent prolapse.

In cataracts with much soft cortex, the nuclei and the

* The iris might be drawn back over the presenting edge of the lens by the curette moved downwards into contact with the iris, were it not for the danger of transferring conjunctival organisms thus into the wound.

greater part of the broken-up cortex slip forward easily through the pupil without undue stretching of the iris. But some lens substance remains, especially behind the upper part of the iris, to be dislodged by external pressure alternated with irrigation, as described in the combined operation. Cortex behind the upper iris may often be displaced downwards into the pupillary area by pressure with the hook or other instrument upon the cornea just below the wound, while pressure is also maintained with the curette upon the sclerotic above. Also, while irrigating, a touch with the point of the nozzle upon the iris is often useful in expelling lens matter lodged behind the iris. It is only to be expected that the douche must prove less effective in removing cortex when the iris is intact than when there is a coloboma; and if a strong current be directed into the posterior chamber (except with the double-current syringe) the iris is apt to be carried by it into the wound. After clearing away all the visible lens substance it may be taken, as a general rule, that a wholly black pupil is a sufficient guarantee that any peripheral cortex still remaining hidden behind the iris is in such small quantity that it may be safely left. One often prefers to leave a small quantity of refractory soft cortex rather than to perform an iridectomy to aid in its removal. But an iridectomy must sometimes be made on this account.

Replacement of Iris.—There is reason for satisfaction when the pupil spontaneously resumes its normal shape, size, and position, after the evacuation of the lens matter. More often the pupil is more or less displaced upwards and perhaps distorted and enlarged. A light touch with curette or spatula introduced into the chamber may effectually replace the iris. Or light massage upon the centre of the cornea with the back of the curette or of a tortoiseshell spoon may induce sufficient contraction of

the sphincter muscle. Occasionally it may be permissible to draw the iris into position with iris forceps passed into the chamber, though I have never practised this means of replacement.

De Wecker and others have recommended irrigation especially as a means of replacing iris at the close of the operation instead of using the curette or repositor, whenever the pupil is displaced and distorted, still more when the iris lies incarcerated or prolapsed in the wound. He and Hofmann introduced eserin solution, $\frac{1}{4}$ to $\frac{1}{2}$ per cent., into the anterior chamber with this object. Elliot* (Madras) describes replacement thus:

"The current is directed first under the lower margin of the iris, then on the lips of the wound from above, and finally, if necessary, over the anterior surface of the iris, the nozzle being inserted in the chamber.... Where iris is retained in the wound by cheesy cortex impacted behind the scleral lip of the wound, the lens matter is dislodged by a stream of fluid directed backwards, or even backwards and upwards. If this fails, a portion of the lens capsule, seen hanging down into the chamber, is seized with iris forceps and drawn towards the centre of the pupil. The upper cul-de-sac of capsule is thus everted and emptied of its contents into the chamber."

The pupil, in spite of these efforts, may still remain displaced a little upwards and either vertically elongated, perhaps pear-shaped, with the apex upwards, or simply enlarged. This shows an injured iris and a consequent liability to prolapse. The same may be shown simply by a quite inert sphincter muscle. The pupil can perhaps be pushed into the normal shape and position without much dilatation, but there is no tendency to spontaneous resumption and no active retention of this normal form, the pupil simply remaining in any shape imparted to it.

* *Ind. Med. Gazette*, xii (1906), 203.

In our work we attributed many of our injured irises and consequent prolapses to the use of knives with slightly dulled edges. Hence rather slow incision, sufficient of it not being completed before all the aqueous had escaped, bringing the iris into contact with the blade. We noticed also that this injury of the iris with the knife occurred more often in the left eye, owing to the laboured incision made with the less expert left hand. Another cause, unrecognized in our earlier practice, was the making of too small a section, embracing two-fifths or less of the corneal circumference. Hence the lens had to move upwards a little behind the iris before it could rotate fully.

The more marked defects necessitate immediate iridectomy; the slighter grades may often be overcome by the instillation of eserin, especially if adrenalin has been used before the operation. A simple instillation of eserin, 4 grains to the ounce, is perhaps advisable as a routine practice after all simple extractions. But when there is any particular occasion to fear prolapse three instillations should be made at intervals of a minute, several drops being used each time to flush out the conjunctival sac. The comparative ineffectiveness of a single instillation, and the need for its repetition thus immediately after operation, are due to the washing away of the solution by tears and probably by aqueous. If the closed lids are watched after the instillation, fluid slightly tinted by the eserin may often be seen to ooze out and to flow away from the outer canthus.

Though eserin is by no means so sure a preventive of prolapse as iridectomy, yet one may decide to give it a trial, because iridectomy at the close of a cataract operation is neither easy of performance nor a very safe*

* Yet de Wecker [*Ann. d'Ocul.*, xciv (1885), 41] recommended the routine performance of iridectomy at this stage, because of the difficulty sometimes experienced in determining earlier whether the consistence and size of the lens were such as to necessitate an excision of iris.

proceeding. The patient may have now 'lost his nerve' and be unable to keep the eye still, and fixation with forceps is practicable even less than before the lens was removed. The lens when present affords some support to the suspensory ligament and posterior capsule. Thus the performance of the iridectomy may possibly lead to a loss of vitreous.

Some operators—*e.g.*, Haab and Pagenstecher—prefer to perform iridectomy whenever the iris does not return readily into position after delivery of the lens. It has been remarked that if a flaccid iris be met with in operating upon one eye of a patient, it will also be found in the fellow eye.

It is not essential that the iridectomy shall be complete. A simple 'buttonhole' is probably quite effective (see below), leaving the pupillary zone of iris untouched. But this partial excision is more difficult to accomplish, particularly because the portion of iris concerned is generally narrowed by the upward displacement of the pupil. It may be attempted, though sometimes the attempt will result in a complete coloboma.

Rather greater care being demanded in the after-treatment of simple extraction, both eyes are kept covered for a day. After this it is usually sufficient to keep one eye bandaged only. The patient must be kept as quiet as possible, and he should be made to sleep well the first night.

Among other means which have been found useful for the prevention of prolapse may be mentioned:

1. Sedatives and soporifics—morphia injections, bromides, etc., before operation.

2. Suture of the wound or of the conjunctival flap;

the subconjunctival operations; also covering the wound with a bridge of conjunctiva (Kuhnt).

Von Millingen suggested corneal contact glasses applied for the day following operation.

PERIPHERAL IRIDECTOMY AND IRIDOTOMY.

Bell Taylor* practised cataract extraction through an opening in the iris at its base, in order to leave the pupil quite untouched, and so to guard against prolapse and impaction of the iris in the wound. He made a small peripheral iridectomy, and then enlarged the opening by a transverse cut on each side with fine scissors. The chief drawbacks to the method were the rather complicated procedure, difficulty in delivering the lens through the opening, and distortion of the pupil afterwards, from the wide separation of the root of the iris.

I made use of a basal opening in the iris, in ten cases of Morgagnian cataract only, for the expulsion of the nucleus. Though only a comparatively small opening was needed, varying with the size of the nucleus, the making of it generally required two snips with the scissors, the iris having to be drawn out of the wound twice for this purpose. The method was abandoned because it introduced an impediment to the subsequent dilatation of the pupil by the loss of the dilator fibres of the iris over a fairly wide area, and dilatation of the pupil was somewhat frequently called for in these cases on account of muddiness of the pupil and iris. The cases were too few in number to enable one to judge whether this early exudation was attributable to bruising of the iris, with some interference with the circulation in the bridge of tissue left. This bridge, in particular, tended to become bound down early by adhesions. A minor advantage of this operation for Morgagnian cataract lay in the fact that only a very small section was needed, just as for ordinary combined extraction of these lenses.

Bajardi† makes a considerable peripheral incision in the iris, through which he expels the whole of the lens cortex. The base

* *The Lancet*, 1871, vol. ii, pp. 634 and 802.

† *La Clinica Oculistica*, Aprile-Luglio, 1905.

of the iris is punctured by de Wecker's blunt-pointed scissors immediately after the corneal section has been made, and the opening is enlarged after the nucleus of the lens has been delivered through the pupil. Pflüger* and Hess have made a small basal iridectomy merely to prevent prolapse, after delivering the lens and cortex through the pupil. Whether this practice be confined or not to cases where attempted simple extraction has led to weakening of the sphincter and distortion of the pupil (see above), the small peripheral opening appears preferable to the complete coloboma of ordinary combined extraction. A sufficient 'sluice gate' is provided for the passage of fluid from the posterior chamber, and there are not the drawbacks of the wider basal iridectomy already mentioned. The shape of the pupil is unaffected. The small opening is frequently covered by the upper lid. And the pupillary bridge of iris, if it retains or quickly regains its tone, may aid in preventing prolapse.

Beckles Chandler,† operating with a basal iridectomy, got four prolapses in 312 extractions; two of the accidents were due to direct violence.

Elliot‡ (Madras) gave peripheral excision of iris a trial, practised *before* delivery of the lens. As is well known, delivery of the lens through the pupil is rendered difficult by the presence of such an artificial opening in the iris. Elliot found the removal of cortex by irrigation much less easy than with a complete coloboma.

Schweigger,§ practising a downward section, has utilized a basal iridotomy to prevent prolapse. After introducing tropococain into the anterior chamber to obtain complete anæsthesia, he pulls the iris forward with fine forceps and makes an extensive peripheral incision with a broad needle. Eserin is then instilled, to widen the opening by contraction of the pupil. The incision generally closes completely later.

Verhoeff‖ (Boston), extends the principle of the key-hole iridectomy into a combined iridectomy and iridotomy. After making a small peripheral buttonhole, he incises the iris from

* *XII Congr. Intern. de Méd. à Moscou* (1898).
† *Arch. of Ophth.*, xxxiii (1904), 1.
‡ *Ind. Med. Gazette*, xli (1906), 203.
§ *Arch. of Ophth.*, xxvii (1898), 255.
‖ Ref. *Arch. of Ophth.*, xxxv (1906), 453.

the opening to the pupil with scissors. "The excision of iris tissue is made where it will be most effective in preventing iris prolapse, and at the same time do the least damage from an optical standpoint. . . ." "The lens is removed with the same ease as in the combined operation, and cortical matter is readily expressed."

A vertical iritomy, or 'sphincterotomy,' is made by Manolescu, Pascheff, and Mark Stevenson (Akron). Pascheff* does this with an "iridotome," consisting essentially of a hook to engage the sphincter within the chamber, and a small knife sliding upon the hook.

PRELIMINARY IRIDECTOMY.

Preliminary or preparatory iridectomy, a few weeks† before extraction of the lens, was practised first by von Graefe. The double operation was found to be somewhat safer than any form of single operation, and only the inconvenience of the prolonged or repeated treatment restricted its application. This inconvenience, especially now that a secondary operation for after-cataract is so frequently performed, is certainly weighty. The value of the method, as compared with the ordinary combined operation, depended upon a reduction in the number of infections,‡ and of prolapses and incarcerations of iris observed after operation.

In practice it is not true that the double operation introduces two chances of infecting the eye. For the iridectomy operation, even in pre-antiseptic days, was almost free from infective risk, and now is practically

* *Wochens. f. Ther. w. Hygiene des Anges*, März 9, 1905.

† The interval between iridectomy and extraction has varied from a few days to eight weeks.

‡ The Moorfields records from 1889-93, however, do not show any marked difference in the proportion of suppurations—1·58 per cent. after extraction with preliminary iridectomy; 1·72 per cent. after the combined operation; 1·78 per cent. after simple extraction (Marshall, *R. L. O. H. Rep.*, xiv, 56).

entirely so. The succeeding extraction proved to be less dangerous than an ordinary combined operation, owing probably to the shortening and simplification of the operation. Involvement of the iris in the wound after the operation has been certainly rare.

A minor advantage claimed is that the extraction is not so likely to be complicated by bleeding, provided sufficient time has elapsed for the scar of the iridectomy wound to become only feebly vascular (and provided the second incision follows the same line as the first. In England, however, the iridectomy incision is usually placed anteriorly to the cataract section). The preliminary operation is also said to have a valuable educational effect upon the patient, and to enable the operator to judge of the behaviour to be expected during the major operation.

Improvement in technique and a better understanding of the origin of infective troubles and of prolapse of iris have practically abolished the need for this division of the operation for ordinary ripe cataracts. In some complicated cataracts, however, the iridectomy as a separate operation may be desirable to show the condition of the lens or to reduce tension. It is performed also in cases where one eye has been lost from profuse hæmorrhage following cataract extraction. And in dealing with unripe cataracts preliminary iridectomy has to-day a considerable vogue as part of Förster's ripening procedure. As already mentioned, a few operators practise the iridectomy alone, without massage of the lens, as a ripening measure.

Hirschberg* laid down preliminary iridectomy as *necessary* where there was high tension, lest, as pointed out by Arlt, extraction should give rise to expulsive hæmorrhage; and also in eyes after sympathetic ophthalmia. He considered it *advantageous* for annular or multiple broad posterior synechiæ; also where there was only the one eye, or where any mental or

* *D. Zeitschr. f. pr. Med.*, 1874, S. 31.

general condition appeared likely to interfere with rest afterwards; and, finally, for Förster's ripening.

Kuhnt practises preparatory iridectomy where there is diabetes, gout, or chronic rheumatism, posterior synechiæ, recent cyclitis, anæsthesia of cornea or suspected glaucoma, and in persons of anxious temperament; Critchett, when trouble from much soft cortex is anticipated; Truc, in indocile subjects.

OTHER MODES OF OPENING THE CAPSULE.

Peripheral Capsulotomy.—The opening of the capsule in the upper periphery stands in direct contrast to the removal of a portion of the capsule. It leaves the whole of the pupillary area occupied by the two layers of capsule.

It was introduced by Gayet* to avoid the drawbacks experienced from tags of capsule left in the pupillary area. He practised combined extraction, and divided the capsule at the equator of the lens after causing the latter to tilt forward into the wound by exerting backward pressure at or below the middle of the cornea.

Quioc† recommended a broad iridectomy, and divided the capsule with a Graefe's knife along the whole length of the wound. He considered the procedure applicable to lenses with softened cortex, and especially to Morgagnian cataracts. From these latter the nucleus escapes much more readily through an upper opening than through a central one.

Knapp still uses "peripheric splitting" systematically for all forms of cataract, and without iridectomy.

He thus describes‡ the procedure: "The operator gives the knife back to the assistant, and takes from him a cystitome, which he introduces into the anterior chamber, with the knee forward, from the temporal side, near the conjunctival flap, which latter he is careful not to drag into the eye. He then advances the instrument so that the tip goes underneath the upper part of the iris, turns it, and with the tooth makes the incision into the upper part of the capsule, parallel with the corneal section, about 6 or 7 millimetres in extent. As soon as the capsule is opened the lens makes a visible forward

* *Gaz. hebd.*, Nr. 35, 1873.
† *Thèse de Paris*, 1879.
‡ Norris and Oliver's 'System,' iii, 798.

motion; then the cystitome is withdrawn again with the knee forward, so that the point does not injure the iris."

The particular advantage is that there are no shreds of capsule to unite with the lacerated pupillary margin, and so the pupil remains free from posterior synechiæ. The lens escapes easily, and entanglement of tags of capsule in the wound cannot take place, though, if an iridectomy be made, there may be adhesion between the capsular and corneal incisions. Cortical remains become enclosed by early union of the capsular incision. Thus irritation of the iris is avoided, but the cortex is only slowly and imperfectly absorbed. The drawback to the method, which has prevented its general adoption, is the necessity for an after-operation in a very large proportion of cases to give permanently clear vision. Rarely, the entrance of blood* into the capsule may give trouble, owing to slow resorption.

Opening of the Capsule at the time of the Corneal Section (Kératokystitomie of Gayet).—It is a very old practice to incise the capsule with the point of the knife as it passes across the anterior chamber. Gayet† first utilized the method on a large scale. Many others have reported favourably and unfavourably upon it, and it is still employed to a small extent. Gayet dipped the point of the knife a little way under the capsule at the middle of the pupil to either raise a flap of the membrane or simply to tear it. Some operators have preferred to extend the puncture vertically. But much movement of the blade tends to slight distortion of the wound surfaces and to premature escape of aqueous and its consequences. Some surgeons have been satisfied with a small puncture, withdrawing the blade sufficiently to free the point, and trusting to the pressure of the lens during delivery to enlarge the opening. The opening is apt to be insufficient except in somewhat unripe cataracts, for in fully ripe and slightly overripes cataracts the capsule may prove to be toughened, though not noticeably opaque. Knapp held the method inapplicable for thickened capsules, also where the pupil was small or the anterior chamber shallow.

There appears to be some slight risk of pressing the lens

* Chisholm, *Report on the Eye and Ear Infirmary*, Baltimore, 1879.

† *Ann. d'Ocul.*, xcv (1886), 227.

backwards in penetrating a thickened capsule, or even of dislocating the lens forward into the anterior chamber (Pflüger) after transfixing the membrane.

To compensate for these disadvantages there is only the simplification of the operation—the combination of two stages into one—and the elimination of an instrument.

Preliminary Capsulotomy.—The opening of the capsule by means of a fine (Bowman's) needle before making the section has been adopted by a few operators. It has formed the routine practice in the Madras hospital.

Haab has occasionally employed the method in juvenile cataracts. It is claimed that useful information is thus obtained as to the size of the nucleus and the consistence of the cortex; also that the capsular opening is made more exactly, since the operator can see better what he is doing, and the point of the needle cannot be hidden by blood, as it may be after the section is made. Also the pupil is wider (dilated with atropin) than after the emptying of the anterior chamber. The needle is inserted at the limbus to obviate escape of aqueous. Should any fluid escape, it suffices to wait a few minutes for its re-accumulation.

The Extraction of Anterior Capsule.

Until 1874, when Förster began the systematic removal of a portion of the transparent anterior capsule, the procedure had been almost entirely confined to opaque thickened capsules. It is now preferred to all forms of capsulotomy, whenever applicable, by numbers of experienced operators. It certainly fulfils the indications (p. 100) better. It is practised both with and without iridectomy. The coloboma is a convenience in that it eliminates the risk of nipping the iris together with the capsule, and permits of forceps being used with numerous teeth to afford an extended grip of the membrane. But apparently the smaller hold taken with the iris intact very frequently suffices for the tearing away of the greater part of the anterior capsule. The rupture tends to take

place near the equator, because the capsule is thinner there than about the pole of the lens.

The patient must look downwards, and the globe is fixed below. Any blood present in the anterior chamber is expressed or washed out as fully as possible. The forceps are introduced at the summit of the wound with the blades closed and directed straight downwards. They are passed down almost to the lower border of the pupil and then slowly opened so that the blades reach to the lateral borders of the pupil. The pupil may be a little widened horizontally by the forceps to allow of a larger hold of the capsule being taken. The ends are then pressed backwards lightly on to the lens and closed.

The next movement of the closed forceps, presumably gripping a fold of capsule, is downwards. The capsule is thus torn above, generally near the equator of the lens, and in simple extraction one can see that the iris is free. Then with slow side-to-side movement the instrument is withdrawn. In combined extraction, if the capsule be not first torn above, it is liable to be drawn into the wound and to tear beyond the wound, leaving a tongue of the membrane impacted.

Should the forceps have failed to seize the capsule, or should the iris have been nipped, the manœuvre of opening and closing the instrument is repeated with the ends directed at an increased angle to the lens. Increasing the angle necessitates some pushing forward of the corneal flap, opening the wound more.

It is difficult to grasp the tense capsule of a swollen lens. In cataracts with soft or fluid cortex the teeth often glide over the surface instead of gripping it, or they may pierce the capsule and tear it irregularly. The forceps may then come away at once, bringing with them little or no capsule. Or, especially in the case of a Morgagnian

cataract with thickened capsule, they may tear away a portion of the membrane; but only after a pull sufficient to rupture the suspensory ligament below. It is considered expedient to open all tense capsules first with the cystitome or sharp hook. But here we tend to needless elaboration, since the use of the cystitome or hook alone may amply suffice. Terson* (père) makes a small opening with a cystitome below in all opaque capsules before using the forceps, much as described on p. 112. It is in general unwise to prolong the stage of the operation unnecessarily, lest the patient's stock of self-command be thus early exhausted. Provided the capsule is not definitely thickened and opaque, the use of the forceps succeeds best in lenses with firm cortex, that is, when the lens is flattened and reduced in bulk from the normal. With an opaque capsule there is some risk of tearing both zonule and capsule simultaneously, or zonule alone, unless the cystitome be used first.

If the pupil be small and rigid, the use of capsule forceps is contra-indicated, unless with a wide iridectomy. The patient must be reliable and quiet, and the fixity of the eye must be assured before one should venture upon prolonged retention of an instrument pointing directly downwards far within the chamber.

Förster and de Wecker have found that the piece of capsule removed has frequently measured 6 or 7 millimetres across, and has therefore included nearly the whole of the anterior capsule, which measures only about 9 millimetres. Thus the freest exit is secured for the lens. Also the chances of capsular shreds becoming entangled in the wound, and of adhesions forming between the margins of the capsular and pupillary openings, are reduced to a minimum. These, however, can be counted only as minor

* *Ann. d'Ocul.*, cxxxix (1903), 420.

benefits, for both of these complications can be usually avoided without removing capsule. And a few fine posterior synechiæ are not of great consequence. The main advantage of partial capsular extraction may be summed up in the fact that it largely reduces the number of needlings required for after-cataract. Enclosure of lenticular remains is practically impossible, and later capsular proliferations and foldings can seldom take place. Treacher Collins* reported that in a series of a hundred extractions using the capsular forceps, only four eyes required subsequent needling. He found that 25 per cent. of his cases got full vision ($\frac{6}{6}$) with only the single operation.

Considering that early discission for the purely capsular forms of after-cataract has now become an extremely safe measure, and affords a more certain promise of permanently clear vision, the gain from the use of capsule forceps does not appear very great. It is more particularly in cases where the capsule is opaque and inelastic at the time of operation that simple division is likely to be insufficient. But here the use of capsule forceps alone becomes dangerous, since the toughened capsule may prove more resistant than the surrounding zonule.

How do the advantages weigh against the risks? There is a real, though small, danger of loss of vitreous from depression of the lens in seizing the capsule, or through movement of the globe with the forceps in the eye, or from the displacement of the lens by the drag upon a tough capsule. The question, like so many others in cataract work, is not one of absolute right or wrong, but is rather one of the selection of suitable cases. Perhaps the risk attaching to the use of the forceps may be quite eliminated by utilizing them only upon steady eyes and suitable cataracts.

* *Brit. Med. Journ.*, 1905, ii, p. 433.

My personal experience of the method is a small one, dating some years back. With either Terson's forceps or Rochon-Duvigneaud's modification I tore away anterior capsule in ten operations, and tried, but failed, to seize the capsule on eight other occasions. In all but one of these eight eyes the cataract was of the swollen, liquefying variety, and the capsule, therefore, presumably tenser than normal. In one case I certainly depressed the lens a little, and got an escape of vitreous, and in one other eye the lens appeared to have been a little displaced by the forceps, but no vitreous was lost. I did not dare to use the instrument except in very quiet patients, and with transparent capsule. It appeared to me to be a clumsy, troublesome, and dangerous instrument compared with the cystitome, and I did not feel impelled to persevere with it.

De Wecker uses forceps only in docile patients, Sattler unless the capsule is tense, Lagrange unless the capsule is too dense. Kuhnt uses forceps or cystitome "according to circumstances."

Birnbacher* outlines a piece of capsule with a special knife to avoid leaving loose shreds behind.

Puncture of Posterior Capsule.—Puncture of the posterior capsule after extracting the lens and completing the toilet of the eye appears to be occasionally indicated. Where it is obvious that discission is needed for some central opacity of the posterior capsule, it saves trouble to perform it at once, instead of as a supplementary operation a fortnight later. But the patient must be steady and there must be no trace of vitreous tension, for one has no right to risk loss of vitreous. I have practised it rarely, using the cystitome, but not always without vitreous accident. The forward pressure of the vitreous distends the small opening, but evidently does not always continue to do so, for Schweigger sometimes found no trace of the opening later. The procedure was advocated especially by Hasner.† It was practised earlier, not only to anticipate trouble from after-cataract, but also to raise the cornea by the displacement of vitreous for the adjustment of the wound margins in cases of rigid sclerotic and corneal

* *Cbl. f. pr. A.*, 1894, S. 70.
† *Prager Med. Wochenschr.*, 1864.

collapse. Sometimes a fairly extensive vertical incision was made in the capsule.

It is best done with the lids separated merely by finger traction. Hasner used a cataract needle for tearing the capsule. Pressure upon the globe with the bandage must be carefully avoided afterwards.

INTRAOCULAR IRRIGATION.

The removal of lens cortex by intraocular irrigation appears to have been first practised by Guérin and Sommer* toward the latter end of the eighteenth century. Water was injected, plain or with additions. Forlenze (1799) used a graduated syringe with flattened nozzle. Maunoir simply allowed fluid to enter through the wound from the conjunctival sac. The procedure was not generally adopted. It fell into disuse, and was forgotten until started anew by McKeown in 1884.† His report was quickly followed by others from Inouye (Tokio), Panas, Vacher, and Wickerkiewicz in 1885 and later. The method gained many adherents, especially in France. McKeown endeavoured particularly to facilitate operation upon unripe and partial cataracts; with this object he injected fluid within the lens capsule by a sharp-pointed needle before attempting expulsion. One of the oldest uses of the introduction of fluid into the eye, still taken advantage of,‡ was to restore the curvature of a collapsed cornea or collapsed eyeball, whether after vitreous loss or not. Vacher and Panas hoped by the use of antiseptic solutions to destroy infective organisms in the wound and in the chambers. As already mentioned, de Wecker, Hofmann,

* See Magnus, *A. f. O.*, xxxiv (1888), 2, 167.

† Report at the Brit. Med. Association Meeting at Belfast.

‡ By Knapp, Lippincott and Pooley in America, by Elliot in Madras, and doubtless by many others.

and Elliot have insisted upon the value of irrigation for replacing the iris in position.

A number of solutions have been employed, including distilled water, normal saline, chlorine water, solutions of boric acid, perchloride, iodide and cyanide of mercury, alcohol, trichloride of iodine, etc. Nuel and Cornil* and Mellinger† came to the conclusion that the only fluids applicable among a considerable number tested were sterilized normal saline and concentrated boric acid solution. Others were liable to cause permanent opacity of the cornea by destruction of its endothelial lining. Irrigation is at present practised a good deal in India. Many prominent surgeons, however—*e.g.*, Fuchs and Pagenstecher—regard it as either dangerous or superfluous. In Bombay we had ten years' experience of it, extending probably to about four thousand operations. For years the douche was employed as freely as the needs of the cases suggested, without thought of possible evil consequences. During this period we were able practically to exclude panophthalmitis as a complication. But milder infections occurred, shown by iritis and irido-cyclitis of varying degrees of intensity. And in trying to get rid of these complications during the last few years we were forced, by a process of exclusion, to the opinion that irrigation was responsible for at least some of them. Latterly better results were obtained under a much more restricted use of the method. There were fewer muddy pupils found the day after operation, and attacks of iritis and irido-cyclitis became rarer and milder (see 'Asepsis').

In our experience, then, the infective risks of intraocular irrigation are real but small, the accidents not being of the gravest. By proper management and by restriction of

* *Arch. d'Opht.*, x (1890), 319.
† *A. f. O.*, xxxvii (1891), 4, 159.

the application of the method, as shown in Chapter II, it may be employed without incurring any appreciable risk at all. In this connexion, however, our treatment of the conjunctiva with strong perchloride must be borne in mind. Possibly without this conjunctival douching infective accidents attributable to the intraocular irrigation might have proved more serious.

I have never hesitated to wash out blood early in the operation to facilitate the capsulotomy. There is not the same probability of some of the fluid being left in the eye at this stage of the operation, as later, after expulsion of the lens.

The fear of infecting the wound from the conjunctiva, just as by over-free instrumentation, has deterred many from trying the method, while the occurrence of unexplained accidents* has induced others to give up the method after trial. Captain Gidney, I.M.S.,† relates two instances of panophthalmitis where the evidence against irrigation was strong. He, irrigating presumably after removal of the speculum, or with the speculum not elevated by the assistant, suggests that the patient's head should be not only tilted to the side but should be well elevated, with chin depressed, to keep the wound above the level of the conjunctival fluid. He alludes also to a minor drawback which the method presents to surgeons who have to operate without trained assistance. Unless they take the trouble personally to ensure that the fluid and apparatus are properly sterilized, there must be reason to fear the introduction of infective material into an eye directly from these sources—sources which are placed beyond consideration in fully staffed and equipped hospitals.

* McKeown had one suppuration and two cases of uveitis in 146 extractions. Lippincott two suppurations and one occluded pupil in 100 operations.

† *Ind. Med. Gazette*, xlii (1907), 450.

A hard-worked surgeon can scarcely be expected to find time for such details unless very decided benefit is to be derived from them.

In another way it has been held (Chibret, Czermak), that irrigation may work indirectly against infection of the eye. It may lessen the opportunities for the multiplication of organisms within the globe, by ensuring the more complete removal of débris upon which the organisms might thrive. But one must be careful not to lay too much stress upon this point. The irrigation may be directly responsible for an early non-infective reactive exudation of lymph, in which bacteria might establish themselves. Maynard says:* "Twenty-four hours after an extraction with irrigation the anterior chamber sometimes looks as if filled with commencing lymph. This all clears away by the second or third day." We have thought, too, that some of our muddy pupils and irises, seen on the day following operation, were ascribable to over-free douching. Possibly this reaction is preventable. It may be due to the use of fluid at an unsuitable temperature. Using the one flask for a number of operations, our solution often became cooled too much. (In a colder climate much more care would have been needed to keep the temperature of the fluid nearly correct). Wanless (Miraj, India) thought that prolonged syringeing gave rise to striped keratitis in some of his cases.

Other accidents due to irrigation are of comparatively little importance because of their rarity. It is obviously possible to do considerable damage with the cannula in the eye. Yet I have only once seen loss of vitreous apparently attributable to irrigation. The accident immediately followed the use of the douche, but I believe the zonule had been ruptured previously. On one other occasion the tip of the cannula was thrust

* 'Manual of Ophthalmic Operations,' Calcutta (1908), p. 66.

through the posterior capsule by sudden movement of the globe, but no vitreous prolapsed. Dr. J. H. Claiborne (America) reported that he once saw extensive irido-dialysis caused. "Irrigation had been performed with but slight pressure with a curette." In Bombay we once had a very unfortunate experience. Fluid containing a little sublimate was used on two successive days. Twenty-two cataracts were extracted, and irrigation was practised in varying quantity in nearly all of the cases. Seventeen of the corneas were made permanently opaque in varying degree. The vision was reduced to perception of moving bodies in a few cases, and at least three of the eyes developed secondary glaucoma. The accident was due to the tubes having been put into the flasks filled with the sublimate solution in which they were sterilized.

There is no question that irrigation was on the whole of great use to us, removing cortex more completely, easily, and quickly than would have been possible otherwise, and enabling us to extract unripe cataracts upon which we would otherwise not have ventured to operate. It enabled us also to utilize a complete conjunctival flap without serious inconvenience, in the days before we instilled adrenalin solution. The wound margins were left cleaner, and this must have helped to promote rapid union.

The use of the douche is contra-indicated in cases of threatened or actual escape or prolapse of vitreous, and therefore in intracapsular extraction of the lens. Though it is employed to fill the anterior chamber in collapse of the cornea and in collapse of the globe, whether after vitreous loss or not, it is probably unnecessary for this purpose, at least in operations with a conjunctival flap.

THE OPEN TREATMENT OF THE WOUND.

Numerous objections have been urged against the occlusive dressing: (1) It has a tendency to induce, or to exaggerate already existing, conjunctival injection and secretion. The heat of the dressing and the stagnation of the fluid in the con-

junctival sac, due to the stoppage of the blinking movements of the lids, promote the development and retention of micro-organisms. The 'physiological toilet' of the eye is interfered with. (2) The bandage is liable to displacement by restlessness during sleep, and it may then do harm by pressing unevenly upon the globe. (3) The pressure of a bandage too tightly applied may cause prolapse of iris (see also p. 147). (4) Frequent inspection of the lids is rendered impracticable. (5) The double covering has been responsible at times for the development of mental depression or delirium.

But these disadvantages may be largely eliminated by care in covering the eye, and by limiting the period of application of the dressing. And there is the benefit of immobility of the eye while the double bandage is in place. Praun* and Czermak† have especially recommended what is sometimes known as the 'modified open' or the 'German' method by 'hollow dressing.' The eyes are covered only by a double Fuchs' shield, well padded at the margins to fit closely, and covered by black cloth to exclude light and dust. Thus completely shaded, the lids are commonly kept closed and the eyes immovable, almost as continuously as if fixed by a dressing. Czermak got less reopening of the wound than with an occlusive dressing. Fuchs applies a dressing under the mask, held by a single strip of linen fixed with soap plaster. Wickerkiewicz,‡ following Wolffberg, simply covers the eye with strong brown silk paper, cut to the required shape, and pasted to the skin over the orbital margin with ordinary gum arabic.

For similar occlusion without dressing, Doyne§ employs a cast of dentist's wax, moulded beforehand. The mask extends beyond the orbital margins. After the cast has set it is removed, and its central portion—that which covers the eye—cut away. It is then replaced, and the defect made good with soft, heated wax, which does not adhere to that which has already set. This loose central portion overlaps the other. After it has set it is thinned, by scraping, to remove it from contact with the eyelids, and perforated for ventilation. The wax must be hard or it may not withstand the heat of the face sufficiently.

In our Bombay work a large absorbent dressing was neces-

* *Cbl. f. pr. A.*, März, 1898.
† *Ibid.*, Mai, 1898.
‡ *Kl. Monats. f. A.*, xlii (1904), 2, 222.
§ Method shown at Oxford, July, 1907.

sary at least for a day, to receive the fluid poured out from the conjunctiva, irritated by the strong perchloride lotion. Where there is this watery discharge the dressing is needed, both for the sake of cleanliness and to obviate wiping and rubbing by the patient, and to prevent excoriation of the skin. Otherwise, there seems to be little advantage in retaining the occlusive dressing longer than twenty-four hours. Observation tends to narrow the period of origin of most of the serious complications to the few hours immediately following operation. And the advantages of immobilization after this period are appreciable only in the case of unreasonable and unintelligent patients. In many of these, however, the unoperated eye must be left uncovered from the beginning.

Some surgeons have used the wire shield alone from the beginning, others transparent celluloid shells fixed by adhesive strapping along their margins and by tapes. These are decidedly preferable to the completely open treatment of Hjort,* affording no protection of any kind against light or injury.

Czermak found closure of the lids by a strip of court plaster necessary (1) when the lid space was so wide as to expose the (upper) section; (2) when the section had been made below, and was, therefore, necessarily exposed between the lids; and (3) after loss of vitreous. A pressure bandage was considered advisable where intraocular hæmorrhage was feared, as in glaucoma.

For various reasons cataract patients have been treated from the beginning as out-patients, walking to their homes a few hours after operation. In up-country practice in India this may be at times necessary. Darier finds that such cases do practically as well as indoor patients.

REMOVAL OF THE LENS TOGETHER WITH ITS CAPSULE.

From the earliest days of cataract extraction operators have made occasional involuntary acquaintance with the delivery of the lens in its unbroken capsule. It happened

* First published in the *Cbl. f. pr. A.*, Mai, 1897. See also Mohilla's results, *Cbl. f. pr. A.*, December, 1899.

in two ways. Either it was a pure accident in which the surgeon had no direct participation, the lens being shot out by reflex closure of the lids, generally with more or less vitreous. Or, owing to rupture of the zonule, whether at the time of operation or earlier (in cases of dislocated lens), escaping vitreous necessitated the introduction of a spoon or loop behind the lens to extract it. And the same instrumental extraction was sometimes practised owing to a difficulty experienced in opening the thickened opaque capsules of some overripe cataracts, or owing to the fear of pressing upon tremulous lenses with the cystitome.

A. Pagenstecher first introduced the deliberate routine extraction of all senile cataracts in their capsules. The method was published* in September, 1865, at the Heidelberg Ophthalmological Congress. The brothers Pagenstecher later restricted the application of the method† to the compulsory cases (dislocated lenses), and to those in which the risks of rupture of the capsule and of loss of vitreous by this method were found to be least. This group included all overripe cataracts, including Morgagnian and shrunken and calcified lenses, in which the generally thickened capsule might be expected to prove stouter than the possibly atrophic zonule. Also cataracts in eyes with pupil occluded by irido-choroiditis, because in these cases the lens was loosened in the fossa patellaris. The operation was found to be inapplicable in unruly patients, and in eyes with vitreous tension, and for cataracts which were barely ripe and had ripened rapidly, whether the ripening were natural or artificial. The tense capsules of these swollen lenses was liable to burst during the extraction. The procedure also was modified

* Personal communication from H. Pagenstecher.

† H. Pagenstecher, 'Die Extraction des grauen Stars in der geschlossen Kapsel' (Wiesbaden, 1873).

by Hermann Pagenstecher. In the earlier operations a large shallow spoon (Fig. 38) was inserted for the withdrawal of the lens, after an iridectomy had been made. Later it was found safer to pass in the spoon only a little way between the lens and the vitreous, to serve as an inclined plane to guide and support the lens, and to keep the vitreous back. Pressure was placed upon the globe by the assistant with a spatula (Fig. 32) at the lower corneal margin. Only when moderate pressure thus applied failed to expel the lens, was the edge of the spoon passed down beyond the posterior pole of the lens, to obtain an upward pull upon the lens, and so to assist in its delivery. At times the spoon was not introduced into the globe at all, but merely used for depressing the upper lip of the wound.

At the present day H. Pagenstecher does not perform intracapsular extraction so frequently as in former days, because he operates generally without iridectomy, and because "the healing process is generally prolonged if there is an escape of even a little vitreous," and because overripe cataracts are getting rare nowadays in Europe.

Numerous modifications in technique have been introduced from time to time without gaining any general adoption. Some of the modifications have been intended for application to senile cataracts in general, others for restricted use only. The wire loop, forceps, and hook have all been employed for extracting the lens. Macnamara* made an outer section without iridectomy, but with previous dilatation of the pupil. He introduced a spoon and depressed the near edge of the lens, causing the latter to rotate, so that it was withdrawn with its posterior surface foremost. Dr. Andrew† operated in the same manner, except that he tore the zonule at the inner side of the lens with a wire hook, introduced either through the incision or, before making the incision, through an outer

* 'A Manual of the Diseases of the Eye,' 2nd edition, 1871.

† *Brit. Med. Journ.*, January, 1883, p. 41.

puncture. Various other attempts have been made to aid in the expulsion of the lens by division of the zonule. Cannstatt (1870) dislocated the lens into the anterior chamber after making the incision, by means of a needle previously inserted through the sclerotic. Roosa (1885) tore the zonule by partly dislocating the lens with the knife. Gradenigo* (1895) and his school have more recently practised separation of the lens from its attachments by a 'zonulotome,' or blunt hook with stem curved to correspond with the lens surface, and also bent like the ordinary Graefe's cystitome. One of his pupils, Ovio, from experimental investigation upon animals' eyes, finds that the risk of vitreous loss is least with only a limited division of the zonule. All of these attempts have been overshadowed by the recent development of the intracapsular operation in India; but Wolkow's† delivery of the lens by pressure and counter-pressure with two spoons requires mention.

The work in India was begun‡ by Mulroney, at Amritsar in the Punjab, in 1890. He made a downward section without iridectomy, and expelled the lens by manipulation. Henry Smith at Jullundur, also in the Punjab, adopted the method, but preferably with an upper section, and latterly with iridectomy. Obtaining better results, he has expanded the work greatly. In 1893, 1,145 of these operations were performed at Amritsar. Now the extractions at Jullundur number nearly three thousand per annum.§ In the year from May 31, 1904, to May 31, 1905, Smith extracted 2,616 cataracts in their capsules, and only 151 with capsulotomy.‖ With this extraordinary experience he has clearly and authoritatively established expression as the correct method of delivering the lens in its capsule, and has shown that it is applicable

* Saggini, *Ann. d'Ocul.*, cxxii (1899), 344.

† *Wjestnik Oftal.*, xi (1894), 366.

‡ Meher Chund, Rai Bahadur. 'New Operation for Cataract at Civil Hospital, Amritsar.' *Trans. Ind. Med. Congress*, 1894.

§ *Ind. Med. Gazette*, xlii (1907), 326.

‖ *Ibid.*, xl (1905), 327 ; and *Archives of Ophth.*, xxxiv (1905), 601.

to the large majority of senile cataracts. He has obtained such unexpectedly good results that he has now many imitators in India; and ophthalmic surgeons generally, especially in America, are more ready to use the method than formerly. Intracapsular expression is not infrequently spoken of as 'Smith's operation.' Smith practises ordinary extraction only in children and for "atrophic" cataracts, and for others with "semi-gelatinous" cortex of a bluish tinge—evidently the rapidly ripening cataracts of Pagenstecher.

Operative Procedure.

Smith says "the details of the operation which I perform are my own," and insists that men must see it done in order to learn the method completely. On the contrary, I can find no detail which has not been practised earlier by others. The originality in Smith's method, if there be any, lies apparently in the omission of detail. And those who have seen Smith operate do not appear to have benefited much, judging from their results. The operation is merely ordinary combined extraction, with the omission of one step—the opening of the capsule.

Unless the patient be very quiet and reliable, the stop-speculum is replaced by retractor for the upper lid, and finger depression of the lower lid, before the expulsion of the lens is attempted. Smith prefers a large strabismus hook to Desmarres' retractor. But with his left hand he also inserts a spoon or vectis under the upper lid "to raise that half of it which is not so fully raised by the assistant's blunt hook. This may be placed at the nasal or temporal side, according to the operator's predilection."* The control of the peripheral fibres of the orbicularis has been already mentioned p. 90.

* Rutter Williamson, *The Ophthalmoscope*, v (1907), 556.

With the assistant standing at the patient's right side, the operator has to pass his right hand under the assistant's left wrist in operating on the left eye.*

Few surgeons will be inclined to follow Smith in making a purely corneal section, with puncture and counter-puncture at the limbus, either in, or 1 millimetre above, the horizontal corneal meridian, and the summit of the arch "half-way between a normal pupil and the sclero-corneal junction." Through this low section Smith is able to deliver the lens whatever be the position of the eye. He "lays stress upon not making the patient look down, as doing so encourages prolapse."†

He employs a strabismus hook for expressing the lens, as was done also earlier at Amritsar. He does not now make use of counter-pressure above the wound with a spoon, as he did formerly. "He finds there is less risk of vitreous escaping if no counter-pressure be used, and the expression of the lens is almost as easy, although a trifle slower.

"With his right hand he places the convexity of a strabismus hook upon the cornea, over the junction of the lower with the middle third of the lens. This is not altered in position till the lens is half-way out. The pressure is directed to the back of the eye, and at first is neither towards the wound nor from it, though when the lens has started on its way there is an almost unconscious slight adaptation of pressure toward the free edges of the wound. When the lens is half-way out the hook is shifted, so as to tilt to some extent the edge of the lens into the concavity of the hook. If the lens sticks, the hook is moved to one or other side without lifting it from cornea or relaxing its pressure, so as to try and disengage the peripheral portions.

* Maynard, 'Manual of Ophthalmic Operations' (1908), p. 110.

† *Ibid.*, p. 112.

"The pressure exerted is moderate, *slow and continuous*, gradually relaxing in amount as the lens is seen to be well on its outward way. The process must be done slower, and with much more deliberation than in the capsule-laceration operation. The continued pressure quickly tires out the iris, which dilates and allows the lens to emerge very like the process of parturition. If the expression be attempted rapidly, the capsule will probably burst just as it is coming out. If this accident does happen, it is best to keep up the pressure with the hook, so that the capsule does not retract, and try and gently drag it out with a pair of ordinary dissecting forceps applied to the part outside the wound. The broad hold so secured will often succeed in drawing out the whole of it with its contained lens matter.

"During all this manipulation the patient is not spoken to, nor asked to aid in any way, either by looking up or down. To do so, most of us have probably found, more often flusters the already nervous patient than succeeds in getting him to do promptly what is requested of him. As a consequence, the generality of patients will be found to turn the eye so that it looks high up into the superior fornix. . . .

"This is an awkward position for the surgeon, though the extraction can quite well be performed with the eye in this position, provided the assistant holds the lids as described."*

Maynard says: "When the lens is half out it will sometimes be found that . . . the operation seems to come to a standstill. In such cases, while keeping up pressure with the strabismus hook, the lens may be gently coaxed out by means of a spoon applied along its edge with safety, provided the spoon be rounded and not sharp, and great

* Rutter Williamson, *loc. cit.*

gentleness be used, so as not to rupture the capsule."* Another aid is "to slowly slide the counter-pressing spoon along the sclera along the outer edge of the wound" (Maynard). "When the lens is half-way out . . . a clear point of vitreous will occasionally appear in the wound behind the lens. . . . The spoon in the left hand . . . should be pushed beneath the lens through the clear point and the lens suspended on it. Once the lens is supported on the spoon the strabismus hook can be used as before to drive out the lens, the spoon merely coming with the lens, but not drawing it out. . . . If we attempt to lift out the lens on the spoon merely, the capsule will give way with exceeding frequency" (Smith).†

In addition to this occasional insertion of the spoon, the iris forceps have sometimes to be introduced to seize ruptured capsule. "If the capsule has retracted, we should try by gentle stroking to press out its contained lens matter, . . . and if the capsule be evident to the eye, we may make an attempt to catch it with an iris forceps and fetch it out."‡ Where no accident occurs the only instrument introduced into the globe is the knife. Ordinary dissecting forceps are used for seizing ruptured capsule lying in the wound.

The amount of pressure required is sometimes considerable. Maynard mentions that during the period in which he performed 175 intracapsular operations, he tried, but failed to expel the lens from eight other eyes with the degree of force which he felt justified in applying. After operation the same care is demanded, whether there has been loss of vitreous or not. At Jullundur both eyes are

* *Ind. Med. Gazette*, xli (1906), 315.

† *Ibid.*, xl (1905), 327. According to Williamson (*loc. cit.*), Smith introduces the same spoon into the eye which he has been using for supporting the upper lid, and this without cleaning it in any way.

‡ Smith, *loc. cit.*

bandaged, and the coverings are not disturbed for four days unless there is pain.

Major Newman * states that he always attempts expulsion within the capsule, but if the lens does not come easily he desists. He thinks that this attempt facilitates the delivery of the lens in the ordinary way after capsulotomy, the pressure applied having altered the shape of the lens and detached the cortex from the capsule. Captain Gidney † performs the intracapsular operation only where he considers the making of a conjunctival flap unnecessary. This because of the possibility of trouble from blood in the anterior chamber, which could not be washed out ‡ after the zonule had been ruptured. Trouble from hæmorrhage could, however, be prevented by the instillation of adrenalin beforehand.

The Drawbacks of the Operation.

1. *Loss of Vitreous.*—The question of the applicability of the method to the general run of senile cataracts hangs mainly upon the risk of vitreous accidents, with their ultimate consequences—infective inflammations, detachment of the retina, atrophy of the globe, etc. The removal of the support afforded to the vitreous by posterior capsule and zonule combined, of necessity adds to the number of vitreous escapes. Even without external pressure the vitreous tension may be sufficient to cause an escape as soon as an opening is made in the supporting diaphragm. Smith's extraordinarily low percentage of escapes—between 6 and 7 per cent., published in 1903,§ and again in 1905‖—came as a revelation of the possibilities in this respect. And it is said that this rate has been further reduced since then. Smith claims that in only nine instances among 2,616 extractions did the loss amount to more than

* *Ind. Med. Gazette*, xli (1906), 403. † *Ibid.*, xlii (1907), 448.

‡ Maynard, however, considers that, if the vitreous has not prolapsed, irrigation may be employed ('Manual of Ophth. Op.,' p. 114).

§ *Brit. Med. Journ.*, September 26, 1903. ‖ *Loc. cit.*

"a bead of vitreous." And these nine accidents were "in supremely nervous patients, who shot out the lens and a quantity of vitreous the moment the incision was completed. . . . The accident in these cases would have occurred in any operation." And these statistics included the extraction of seventy-five lenses couched by quacks. No other operator has succeeded in approaching this low percentage. Captain Oxley,* a beginner, in his first series of forty intracapsular extractions lost vitreous in 30 per cent. of the cases. In a second series of forty cases the losses amounted to 40 per cent. Major Birdwood,† in a total experience of 311 of these operations, had at first vitreous escape in 47 per cent. of the cases, later in 37 per cent. He does not think the average operator can expect to reduce the proportion of accidents below 30 per cent. Maynard‡ lost vitreous in 38·28 per cent. of the cases in a series of 175 intracapsular operations. By the ordinary method he had 4·3 per cent. of vitreous accidents in a late series of a thousand extractions; in an earlier series of a thousand cases the percentage was 6·3. (For other figures showing the proportion of accidents by ordinary extraction, see pp. 169 and 170.) Drake Brockman,§ operating by Pagenstecher's method, had 28·67 per cent. of vitreous losses in 293 operations.

2. *Rupture of the Capsule* "when the lens is partly out," and when, therefore, the zonule has already given way, is regarded by Smith as the most serious accident met with at the time of operation. Efforts to extract the capsule and its contained cortex, as above given, may prove unavailing. Smith had to leave the capsule behind in slightly more than half the cases of rupture, and much

* *Ind. Med. Gazette*, xl (1905), 456, and xli (1906), 482.
† *Ibid.*, xli (1906), 201. ‡ *Loc. cit.*
§ *The Ophthalmoscope*, iv (1906), 121.

cortical matter was often left, either within the capsule or lying in the anterior chamber. He does not mention any attempts to remove or to displace the capsule later. Folded capsule and cortical remains lying in the pupillary area must often interfere greatly with vision. Smith had rupture of the capsule in 8 per cent. of his operations, Maynard in 17·14 per cent. In one-third of these latter there was escape of vitreous also. Maynard says: "More than half the indifferent and nearly half the bad results of the whole series were in cases in which the capsule had ruptured." He thinks that the capsule "loosened from its surroundings is more likely to become entangled in the wound."*

3. *Incarceration and Prolapse of Iris* must be met with somewhat more frequently after this operation than when the capsule is left. This follows from the higher proportion of vitreous accidents. Birdwood† says: "There seems to be a great tendency for the iris to be caught in the angles of the wound at each side. . . . If the vitreous is escaping, it is best to leave them alone." Maynard got prolapse of iris five times and incarceration three times in his 175 operations. He says this is above the average of ordinary combined extraction. Arnold Knapp,‡ during a visit to Jullundur, saw 17 prolapses or incarcerations in 104 intracapsular extractions, but the operations were mostly without iridectomy. The complication is much more serious after intracapsular extraction, because the risk of loss of vitreous in removing the prolapse is much greater. If vitreous has already been lost at the time of operation, any attempt at early excision of the prolapse is absolutely barred.

* Against this is to be counted the fact that in the numerous cases in which the operation is successful there is no capsule left to become impacted.

† *Loc. cit.* ‡ *Arch. of Ophth.*, xxxvii (1908), 13.

4. *Enlarged Pupil.*—Maynard finds that even where there has been no vitreous escape the pupil tends to be noticeably enlarged. The distorted and displaced pupils after some vitreous losses are mentioned on p. 173. Maynard saw drawing up of the pupil in four cases in which there had been no loss of vitreous, and in which there was no iritis.

5. *Corneal Opacity.*—Maynard had three cases of permanent haziness of the cornea, *with low tension* and vision only the perception of moving bodies or of light. In one of these cases the wound gaped for a month, and lymph appeared in the wound.

6. *Indefinite Ailments.*—Maynard mentions two cases in which the eye remained for long red, painful, and slightly chemosed, with vision never good. In one of these (possibly infective) cases the pupil became drawn up. (This is in addition to the four cases mentioned above.) Maynard suggests that this irritability of the eye may be due to the amount of pressure employed.

7. *Delayed Union* of the wound was complained of by Maynard in seven of his cases, in spite of conjunctival flaps having been made in six of the cases.

8. *Post-operative Astigmatism* is said to be greater after intracapsular extraction.*

Advantages.—Some surgeons, impressed by Smith's reports, are inclined to 'strain a point' in favour of intracapsular extraction, feeling that it gives an ideal result when successful. But there is no doubt that a successful ordinary simple extraction, followed by satisfactory early needling, gives a slightly superior result. Thus a small mobile, perfectly black pupil is obtained, to compare with the widened pupil and the coloboma† of the intracapsular method.

1. The one definite advantage of the method, as applied to cataracts which can be extracted in the usual way, is

* Czermak, 'Die Augen. Operationen,' S. 1047.

† Smith formerly performed the intracapsular operation frequently without iridectomy, but his later practice and the experience of others show that it is generally unwise to omit both capsulotomy and iridectomy.

that when successful it once and for all time eliminates all possibility of trouble from after-cataract. Until recently this was a considerable gain, and even now it is often an advantage not to be despised. The precise value of the removal of the capsule is this:

(*a*) A fair proportion of the patients are saved from the trivial annoyance of an insignificant secondary operation ten or twelve days after the extraction. (In Smith's work it is an advantage that the patients need not be kept in hospital so long as ten or twelve days.)

(*b*) A number of others eventually see better than they would do under the usual treatment. This applies to cases in which, after ordinary extraction, there does not seem to be sufficient need for early discission, and in which after-cataract develops later. Many of these patients do not give us the opportunity of remedying the defect, and in other cases late discission fails to effect a wide central opening in the membrane.

(*c*) In the remaining cases in which no central opacity would develop in the capsule, were it left in the eye, no benefit is secured by intracapsular extraction of the lens. And sometimes, at least the early visual result is poorer than it would have been otherwise. Whatever be the explanation, we have been struck by the absence of any marked superiority in early visual results* in Bombay after the intracapsular operation, as compared with ordinary cases. This in spite of more or less after-cataract frequently left untreated. Maynard had a more striking experience in this respect. In 33 of his cases the

* The statement applies only to tests made at the time of discharge from hospital. I have no knowledge of the final visual results. The vision was tested usually with spherical lenses only, and the pupils were mostly still dilated with atropin. But in a few cases unsuccessful attempts were made to bring the vision nearly to the normal, by correcting the astigmatism and by the use of a stenopaic disc.

two eyes of the patient were operated upon, the one eye intracapsularly, the other eye without removal of the capsule. In only 7 instances was the visual result better by the intracapsular method, in 10 cases it was equal in the two eyes, and in 15 instances it was better by the ordinary operation. (The remaining case of the 33 was not available for the comparison, as in this case the intracapsular operation was a failure.)

2. Troubles with capsule—entanglements in the wound, and adhesions to cornea and to iris—are, of course, impossible.

3. Pagenstecher* says that in early days the greatest advantage of the intracapsular method was considered to be the *prevention of iritis*, but that since the introduction of aseptic measures this advantage is no longer so evident. Smith reported only two cases of iritis in 2,494 extractions in unbroken capsule, whereas in 263 operations of the same period in which capsule was accidentally (after rupture) or purposely left behind, iritis occurred in 5 per cent. of the cases. In our small Bombay experience of extraction of lens and capsule, the bright appearance of the iris afterwards was often noticed. The only obvious explanation is the absence of irritation of the iris by particles of lens substance. This should not be a matter of much importance, since it is generally accepted that nearly all severe iritis after operation is due to microbic agency. In Bombay we were able to reduce the proportion of closed pupils from iritis to a very low figure (p. 270) after the ordinary operation. But we often had to use atropin freely for some little time. In cases of mild infection doubtless the additional strain thrown upon the iris by the irritation of lens débris may cause trouble.

Opinions are likely to be widely divided, for some years

* Personal communication.

at least, upon the merits and demerits of extraction in the capsule. Maynard, after his trial of it, concluded: "In face of these grave drawbacks it is impossible to recommend the performance of the operation, and personally I have returned to the practice of removing lenses in their capsules only when they are overripe and have thick capsules." He is at present employing the method, however, for unripe cataracts also.* Birdwood, in spite of an appalling number of vitreous losses, was "gradually getting convinced that it should be the operation of election in nearly all cases." In Bombay the tendency of late years has been more and more away from the intracapsular method. The number of these operations has been reduced to the absolute minimum.

During 1905 and 1906, at the Cowasjee Jehangir Hospital, there were only twenty-four lenses removed in their capsules among 1,262 flap extractions—*i.e.*, in barely 2 per cent. of the cases. Four of these lenses were forced out without help from the operator, three by spasm of the lids, and one by vitreous tension. In four cases there was previous dislocation of the lens, and in another subluxation. Four other lenses became dislocated during the making of the section. In all the other eleven cases the capsulotomy proved insufficient, or the zonule became torn by the pull of the cystitome. Four of these eleven cataracts were Morgagnian, and three others had been Morgagnian, but only the nucleus and capsule remained. The intracapsular delivery was in all cases obligatory or accidental. It is, perhaps, interesting to note in how small a proportion of cataracts the method is forced upon one even in India. In Europe and America, where overripe cataracts are much less common, the proportion should be still lower.

During the same two years we extracted twenty-two capsules entire after expulsion of the lens, with three vitreous escapes. (Only one of these escapes was in the least degree attributable to the removal of the capsule.) There were also three removals of portions of capsule, and five punctures of

* 'Manual of Ophth. Op.,' p. 107.

posterior capsule. In one of these latter there was one vitreous loss, due to vitreous tension.

Among the intracapsular extractions the proportion of vitreous loss was higher, but the vitreous accident was frequently the cause, and not the consequence, of the intracapsular method of operation.

The unintentional intracapsular expulsion of Morgagnian nuclei has been dealt with on p. 122, the procedure being the same whether the fluid part of the lens has been evacuated by puncture with the cystitome, or has been slowly absorbed by natural processes before operation. Even in cases where the zonule has not been torn below by the pull of the cystitome, the intracapsular expulsion of a Morgagnian nucleus by the light pushing strokes upon the cornea already described is at least as safe a proceeding as the deliberate expression of a Morgagnian lens in its unopened capsule.

It is always possible that the pull upon very opaque anterior capsule with forceps, as described on p. 112, may result in the partial or complete intracapsular delivery of a shrunken overripe lens. A sharp hook has sometimes been used instead of forceps to pull out shrunken cataracts, mainly capsular. Forceps or hook must be employed for the withdrawal of such lenses whenever vitreous comes forward in front of the capsule through a rupture of the zonule below. In some rare juvenile cataracts, chiefly capsular, the sharp hook may serve best.

There are two advantages in always attempting ordinary extraction. Firstly, it is not until the contents of opaque capsule have been removed that one can be sure of the state of the posterior portion of the membrane. The lateral displacement of an anterior plaque of fair size brought about by the expulsion of the lens, or its extraction with iris forceps before the delivery of the lens, may

be sufficient to leave the central pupillary area clear and black, the posterior capsule being possibly quite normal. In my experience such displacement of opaque anterior capsule is permanent.

Secondly, if the posterior capsule be found also more or less opaque, or if the displacement of a large anterior plaque be insufficient, one has the option of removing the opaque membrane at once, wholly or in part, or of deferring its treatment until after the healing of the wound. The latter decision will be taken if the patient have become excited and cannot keep the eye still, or if there be any sign of vitreous tension. Even at a later secondary operation discretion may suggest the tearing and displacement of the opaque membrane by two needles, rather than to risk prolapse or loss of vitreous in extracting the membrane. Ordinarily, however, the immediate extraction of opaque capsule is indicated, if the opacity be situated so as to affect the visual acuteness of the eye. Thus we avoid delay and worry and the patient's dissatisfaction over a secondary operation. And loss of vitreous is no more likely to be caused in a quiet patient by this immediate removal than by secondary extraction. The most opaque and thickened portions of capsule are often a little displaced upwards, and are thus within easy reach of iris forceps introduced through the incision. The extraction of the membrane is accomplished after the conjunctival toilet has been completed, and usually also after the substitution of Desmarres' retractor for the stop-speculum.

Elliot* in ordinary extraction removes with iris forceps any tags of capsule visible after the chamber has been washed clear. He did this in thirty out of 200 operations. There were five small vitreous losses among these thirty eyes, and exactly the same number of small losses among the remaining

* *Ind. Med. Gazette*, xli (1906), 163.

170 eyes. He considers this small addition to the operation a much less dangerous proceeding than expression of the lens in its capsule, " inasmuch as it is quite easy to limit the vitreous escape by at once closing the eye as soon as danger threatens. The lens being out, this is, of course, possible."

One is satisfied with the least of the measures calculated to provide a clear central area for vision, and to guard against impaction of the capsule in the wound. The practical result should be as good as by intracapsular extraction of the lens, but the risk of large vitreous escape is less.

Occasionally after the ordinary delivery of the lens, opacity may be found confined to the central area of the posterior capsule, in the form of a circular patch or ring. Without waiting to inquire into the nature of this opacity —whether, for instance, it may not be lens substance capable of being absorbed—I have punctured the capsule. This puncture might, however, be more safely deferred till the day before the patient's discharge.

ASEPSIS.

The problem of the exclusion of exogenous infection still constitutes one of the most vital questions in cataract work. For infective complications varying in number and gravity still occur in the practice of every ophthalmic surgeon of large experience. And few have reason to feel altogether secure against even the gravest of these accidents—destructive irido-cyclitis and panophthalmitis. The question is a very serious one, since theoretically these troubles are preventable. Yet in the practice of the vast majority of eye surgeons there is a definite though very small percentage of total and irreparable loss of vision thus brought about, and sympathetic involvement

of the fellow eye is also met with. Minor grades of infection are not always clearly recognizable, but nearly all troublesome iritis and irido-cyclitis, and probably many quite transient exudations are attributable, in part at least, to infective origin. We know that micro-organisms capable of exciting such reactions are frequently present in the conjunctival sac at the time of operation, and it would be strange if there were no minor grades of infection leading up to those destructive affections which are by common consent admitted as due to bacterial agency. And often there is no other cause assignable for the iritis met with.

The problem as generally accepted may be briefly stated. Modern aseptic surgical principles demand (1) a sterile field of operation, and also (2) that everything which may come in contact with the wound surfaces must be sterile also. (3) Afterwards the conditions must be such as to favour early union, and the wound must be protected against external influences.

The first of these three stipulations cannot be met fully in ordinary present-day hospital work. There is no provision made for the regular and repeated bacteriological examination of the eyes—an examination requiring a considerable expenditure of time in culture tests. Nor can patients suffering from chronic conjunctivitis, especially those coming from a distance, always afford time for the weeks or, perhaps, months of treatment required to free their conjunctivæ from dangerous organisms. Nor can the removal of these organisms be quite assured by douching and swabbing immediately before operation. (It is unnecessary to refer again in detail to the measures adopted in dealing with inflammation of the tear sac.)

The question therefore becomes one of compromise. We take such means as appear to be indicated for cleans-

ing the field of operation. But knowing that the cleansing is often imperfect, we try to avoid transferring organisms from the conjunctival surface into the wound by instruments and lotions during operation. We avoid unnecessary bruising of the tissues, likely to reduce their resisting powers, and we leave as little blood-clot and lens cortex in the eye as possible—materials which might serve as culture media for infective organisms. And we protect the wound afterwards with a conjunctival covering, and avoid as much as possible the exposure of iris or of vitreous prolapsed in the wound. Where the danger appears especially great from an unhealthy conjunctiva, or owing to some general condition enfeebling the tissues, there is the additional safeguard of the subconjunctival operation.

There is thus room for the exercise of individual discretion and judgment. The indications are not exact. We cannot hope always to exclude pyogenic bacteria, but we can limit their numbers and perhaps lessen their vitality, and make the conditions unsuitable for their multiplication. Experience has shown that by the strenuous application of such precautionary measures the evil of the imperfectly sterilized field may be largely neutralized. In Bombay we claim to have been exceptionally successful in warding off infection, but the success has been ascribed primarily to a more effectual cleansing of the conjunctiva than is commonly practised.

India affords a fine field for *conjunctival antisepsis*. With the conjunctiva in so many cases unhealthy, the cleansing of the field of operation becomes by far the most important and critical item in our armamentarium for the defence of the wound. One of the main lessons to be drawn from cataract work in India is that the major operation can be quite safely performed in the presence of slight chronic

conjunctivitis. But to the best of my knowledge safety has been attained only with the help of perchloride irrigation. The first series of good results published in India, unbroken as regards suppurations, was that of 210 extractions by Surgeon Major Bamber, with 1 in 2,000 perchloride. It was reported at the Indian Medical Congress, 1894. And Smith's Jullundur statistics, under the conditions of work there, may be accepted as proof of the value of the same solution. Our Bombay figures afford more detailed and conclusive clinical evidence of almost complete safety attained by the use of a rather weaker lotion systematically applied. Compared with clear clinical evidence in this question, laboratory findings are of little account. And any explanation of the mode of working is also of quite minor importance to the establishment of the essential clinical fact. But for this large figures are needed. Even in India, with the conjunctival danger so constantly present, an experience of at least a thousand operations is needed to show conclusively the essential merits or defects of any treatment adopted. Only small differences in results under rival methods of treatment are to be expected, when we consider the astonishingly low percentage of failures of the pre-antiseptic days.

My personal experience of infection in hospital cataract work* under perchloride treatment of the conjunctiva may be briefly summed up. It is broken up into periods by intervals of leave-taking.

The statistics up to the end of January, 1901, were published in the *Indian Medical Gazette*, June, 1901, thus:

With 1 in 3,000 sublimate lotion freely used there was

* No definite records of my private work are available, but it may be stated that there were no suppurations at any time, and very little iritis or irido-cyclitis.

a series of 497 extractions completely exempt from grave infection.

With the same fluid rather more sparingly applied, in 578 extractions there were three grave primary infections, irido-cyclitis ending in atrophy of the globe.

Where not only the quantity, but in most instances the strength also of the antiseptic was reduced, panophthalmitis followed thrice in 349 operations, and there were seven closed pupils from iritis or irido-cyclitis. (Closure of some of these pupils might, however, possibly have been prevented by freer use of atropin.)

Then followed a period up to the end of March, 1903, in which 1,172 extractions were performed under the perchloride treatment as at present carried out. There was one suppuration, but "no infective iritis or irido-cyclitis severe enough to have resisted energetic treatment."*

Finally came a period of work from October, 1904, to April, 1907. It included 1,655 extractions. There were no suppurations, and the only complications recognizable as severe infective results at the time of discharge from hospital were two cases of iritis closing the pupils, probably susceptible of remedy later by artificial pupil. There were also the two untreated cases of sympathetic disease described in Chapter V, in which loss of sight was attributable largely to neglect, and a third case of loss of sight from chronic cyclitis.

We can claim, therefore, a near approach to perfection in final results in this latest series of operations, so far as uncontrolled infective inflammation is concerned. But it was only towards the end that we felt fairly safe in this respect. For, besides the three losses, there were, until towards

* 'The Practical Details of Cataract Extraction,' 2nd edition, 1903, pp. 53 and 54.

the end, numerous early exudations, which we regarded as partly at least representing infective agency. And during this period we had also one destructive irido-cyclitis in private practice. The minor manifestations of reaction became decidedly less frequent latterly. And it was this which inspired confidence that the graver accidents might be entirely warded off, and that we could hope to go on operating indefinitely without meeting with suppurations or uncontrollable irido-cyclitis. But this recent improvement was not brought about by any change in the treatment of the conjunctiva. It followed the adoption (1) of the mouth-screen during operation, and (2) of enhanced precautions in connexion with intraocular irrigation. Except for the variations in the perchloride treatment mentioned, these changes, both recent, were the only ones made during the whole of the periods under review, which could have had any influence upon infective complications.*

Considering, therefore, the large number of unhealthy conjunctivæ in the eyes operated upon, the influence of the sublimate douching must have been very great in enabling us to attain to the results just recorded. And the figures themselves afford evidence of insufficient protection when less lotion or weaker lotion was used.

The very bad bacteriological condition of the Bombay conjunctivæ, and the effect of the perchloride in removing organisms from them, were directly shown by the examination of a consecutive series of fifty cataract cases just before operation.

The details of the research were published in *The Ophthalmoscope*, iv (1906), 674. In twenty-four of the fifty conjunctivæ

* Another change which should be mentioned here was the fairly frequent performance of subconjunctival operations. But this merely enabled us to operate in cases which we should otherwise have refused for the time being. Our infections have never come when most feared.

there were few or no bacteria except diptheroid bacilli (possibly all xerosis bacilli) before or after the sublimate douching. In all the remaining cases other organisms were fairly plentiful or decidedly numerous. They comprised white staphylococci alone in five cases. Most of the other conjunctivæ contained more than one variety of organism in addition to the saprophytic diphtheroids. Besides white cocci, some of them possibly pathogenic, coloured cocci were fairly numerous, including *Staphylococcus aureus* and *citreus*, and others unidentified, and probably in some cases incompletely separated. Morax-Axenfeld diplo-bacilli were found in five cases, and they were numerous in two of the five. Numerous pneumococci were found once,* and numerous streptococci once. In four of these twenty-six cases the effect of the perchloride douching appeared to be insufficient, several colonies being grown from each conjunctiva afterwards. But in the remainder the effect of the treatment was definite, and possibly sufficient. Either no growth was obtained afterwards or only very few colonies—a single colony in nine instances, two colonies in three cases, and four colonies once. These results were obtained ten minutes after the perchloride douching—*i.e.*, immediately after the cocain instillation. They do not include, therefore, the further effect which would be derived from the supplementary small douching nearly always added immediately before operating. If the result had been tested after operation, a more complete clearance of organisms could have been anticipated.

It is worthy of mention that, though hundreds of colonies of diphtheroid bacilli were grown from some conjunctivæ before irrigation, not a single one was obtained after irrigation. Diplo-bacilli seem also easy of removal; no growth was obtained from the treated conjunctivæ. Staphylococci, on the other hand, in general proved more resistant, and this was the case whether they were present in large or small numbers. This resistance suggests frequent embedding of the cocci rather deeply in the conjunctival epithelium. In several cases a delay of a day or two was noted in the appearance of the colonies grown from the conjunctivæ after treatment, suggesting some direct action of the antiseptic upon the bacteria.

* In a conjunctiva normal except for slight injection and roughness.

It seems probable that in similar tests carried out years ago by others sufficient time was not allowed for the action of the perchloride to manifest itself. Bach* even found mechanical cleansing with salt solution more efficacious. A germicide was looked for. And when perchloride was found ineffective in this respect, like other antiseptics as applied to the conjunctiva before operation, it was thought to be useless, and even harmful, because irritating. Perchloride is of use here mainly because of its irritant and coagulative action upon the conjunctiva. It excites a secretion of mucus, in which micro-organisms are entangled and washed away, and microbes also probably become imprisoned in the epithelium which undergoes coagulation-necrosis. Finally, in cases where much lotion is used, it may directly attack the vitality of the organisms. A sterile field of operation is by no means assured, but of this we had already been made aware by our clinical results.

With danger so frequently present and so obvious in the Indian conjunctiva it seems strange, at first thought, that it can be so constantly avoided. But the very frequency of the danger is the patient's salvation, for it has led to a lavish and regular employment of the necessary precautionary measure. In European and American practice the danger is possibly greater, because it is insidious and comparatively rare. Precaution is unnecessary in the large majority of cases, and in cases where it is required the signs indicative of the necessity may be not very obvious. In any case the tendency is to minimize uncustomary irritative measures, from fear of exciting reaction. Considering the very good results which have been obtained with simple mechanical cleansing, surgeons accustomed to working upon normal conjunctivæ are

* Ref. Haab, 'Operative Ophthalmology,' p. 41.

naturally loth to use any irritating chemical. But they must be quite sure of obtaining the good results. And recognizing the great help derived from perchloride in India, they should not be reluctant to make free use of this protection in cases where there is any suspicion of danger. Since we are working in the dark to a large extent, the precautions must err rather in direction of excess if uniform safety is to be attained.

In deciding upon the relative advantages, or, rather, the applicability of chemical and of simple mechanical cleansing of the conjunctiva, it is in no sense a question of antisepsis *versus* asepsis. In no case is the solution used after the operation has been begun. Elliot (Madras) is the only surgeon of large experience in India who has reported any extensive trial of simple mechanical cleansing of the conjunctiva before operation. He sedulously treated cases of conjunctivitis beforehand, accommodating the patients with sleeping space on the hospital floor when necessary. But the results were not quite good enough, and the method has been replaced by perchloride treatment exactly as practised in Bombay, combined with free subsequent swabbing of the conjunctiva.* Elliot is now strongly in favour of this plan of treatment, and feels, with me, that suppuration ought never to occur. He has had a thousand consecutive extractions with only one suppuration. And this one catastrophe was in a case where the lacrymal sac had been imperfectly excised.

In Bombay we regarded the skin of the lids and surrounding parts, and even the lid margins, as almost outside the field of operation. So far as the lid borders are concerned, this was unsound, for we found it necessary to express the secretion from the Meibomian glands, in order that some of the secretion should not be floated up from the lid borders to the neigh-

* Personal communication. Report to appear shortly in the *Ind. Med. Gazette.*

bourhood of the wound during intraocular irrigation. It is, therefore, obvious that micro-organisms might be also thus carried up to the wound in irrigating fluid. We were always careful, however, to wipe away the expressed Meibomian secretion with perchloride swabs.

The second requirement laid down for the avoidance of contamination of the wound applies to instruments, lotions, the lid borders, and the surgeon's and the attendant's saliva. There is no excuse for imperfect sterilization of instruments beforehand. But during operation considerable watchfulness is required to avoid soiling an instrument before its entry into the wound, by unnecessary contact with the conjunctival surface,* still more with the lid margin. And in repeated introduction of the same instrument into the eye one must remember to cleanse it afresh. Sufficient has been said already with regard to the dangers of unnecessary instrumentation and especially of intraocular irrigation; and one objection to excessive instrumentation is, perhaps, the possibility of diminishing the resistance of the tissues by slight traumatism. The risk of contact between the lid borders and the edges of the wound is the chief objection to separation of the lids by finger traction.

It stands as a confession of weakness and of ignorance, that a prolonged operation must be admitted practically as a danger in itself. Since we do not work in a sterile field, and since we are often uncertain both of the source and of the exact mode of conveyance of the organisms into the wound, prolongation of the period of exposure to contamination must enhance the risks. The benefits of rapidity and simplicity of procedure are seen in work such as Trousseau's.† Introducing only one instrument, the

* Note the suggestion made on p. 192 with regard to the possible value of the conjunctival flap in this respect.

† *La Clinique Ophtal.*, November 25, 1905.

knife, into the eye, he has had only 2 per cent. of iritis and no suppurations, though no special treatment of the conjunctiva had been adopted, and though cortical débris must have been left in the eye frequently. Smith's comparative success at Jullundur is also thought to be partly attributable to the introduction of but the one instrument within the globe.* In analyzing results the operative technique must be considered as a whole. In our Bombay work with more prolonged exposure and more elaborate detail, probably considerably more care was needed to avoid infection, quite apart from the bad average state of the conjunctiva.

For the protection of the wound against secondary infection during the healing period the value of a scleral incision and a conjunctival covering, especially of the complete covering provided by Czermak's operation, cannot be disputed; otherwise, a smooth section† and close coaptation of the wound surfaces are designed especially to secure rapid healing. In addition, measures to preclude reopening of the wound (either by occlusive bandage or 'modified open' dressing), and prompt excision of uncovered prolapsed iris, are the chief safeguards. But the danger at this period would appear to be a minor one compared with the risks during operation, for results appear to vary chiefly with the measures adopted for protection during operation. Nature provides for early union by fairly close apposition of the wound surfaces without the need of sutures, and by maintenance of the parts at rest, protected against outside influences by the upper lid.

* *The Ophthalmoscope*, v (1907), 558.

† Hotta (*Clin. Monats. f. Augen*, September, 1905) published an account of some interesting experiments upon the infection of corneal wounds in rabbits with human saliva, showing the influence of the character of the wound. There was no infection of thirty smoothly-cut incisions with a Graefe's knife, and invariable infection in thirty 'pocket' wounds.

An attempt has been made by Rogman* to heighten the resistance of the tissues against microbic invasion by the injection of 5 to 10 cubic centimetres of a mixture of anti-streptococcus serum (Menzer) and anti-pneumococcus serum (Röhmer). It was employed for an iridectomy in a patient with dacryocystitis, and for cataract extraction in a patient with ozæna. Louis Dor administers 2 grammes of potassium iodide the night before operation with the same idea of reducing the risk of infective inflammations.

Endogenous infection, appealed to as an excuse for bad results, is a refuge of the destitute. Apparently undoubted cases of destructive metastatic inflammation of the eye have been reported after cataract extraction. Hildebrandt† reported a case due apparently to acute rheumatism, and Wopfner‡ one due to pneumonia from Friedländer's pneumo-bacillus. It is, however, certain that infection from within is not to be feared in healthy people. It is well that suppuration at a distance, ulcers, fistulæ, etc.—possible starting points of pyæmia—should be treated before operating.

The general trend of recent work is to fix the responsibility for infective accidents very definitely upon the surgeon. In the not distant future we may find this responsibility recognised by the patient, and possibly upheld in law courts. No exceptional skill is required in the application of the scheme of defence. Simply the measures must be complete in every detail, and carried out with extreme care.

RESULTS.

Bad Results may be due to:

I. **Defective Operation**, particularized in

(*a*) *Incorrect Method;* especially (1) inefficient measures for securing asepsis, or (2) inherent defects in the operative technique adopted.

* *Bull. de la Société belge d'Ophtal.*, Mai, 1904.
† *Beitr. zur Augen.*, viii (1893), 33.
‡ *Kl. Monats. f. A.*, xliv (1906), 1, 386.

(*b*) *Want of Skill* on the part of the surgeon, or less commonly, of his assistant. Dexterity in operating is made up of three elements, rising in order of importance thus: (1) A steady hand; (2) a light hand, combining a fine muscular sense with a delicate sense of touch; and (3), the most important, experience.

Nos. 1 and 2 are best developed by training apart from actual operative work. Though No. 1 conduces particularly to *pretty* operations, No. 2 is more helpful in getting over difficulties and preventing accidents. Very nimble fingers are not required. No. 3 means a prompt recognition of the particular features of each case, and of difficulties and dangers as they arise. Practical experience can only to a limited extent be replaced by reading and by seeing others operate, and by operating upon dead eyes.

(*c*) *Want of Control* on the part of the patient. This may render the best efforts of the skilled hand unavailing; but the discerning operator may very often judge beforehand when trouble from this cause is likely to be encountered, and lessen the dangers by suitable precautions (p. 168).

II. **Eyes more or less unfit for operation.** The surgeon may have failed to realize the conditions, or he may have accepted risks under the pressure of circumstances, or he may have rightly decided to expect only a poor result, where no better was obtainable. The attainment of even poor vision may prove to have been impossible, the data available not having given sufficiently definite indications beforehand.

Our Bombay results, as regards infection, have been already given. The following is an **Analysis of Visual Results** of the flap extractions performed during 1905 and 1906, as seen at the time of discharge from hospital:

Total Operations, 1,262.

Bad Results = vision *nil*, or moving bodies only, 22 = 1·7 per cent.

Of these bad results, three were of a purely temporary nature, and accounted for by cortex or blood covering the pupillary area. Twelve others were due to pre-existing disease of the eye, including old irido-cyclitis, vitreous opacity, choroidal atrophy, optic atrophy, glaucoma, corneal opacity (one case, together with cortex left behind). There were seven failures due to the operation itself = 0·5 per cent. Three of these failures were due to expulsive hæmorrhage, one to large fundus hæmorrhage (not expulsive), one to (?) hæmorrhagic detachment of choroid (a large spontaneous loss of vitreous occurred during operation). The remaining two failures were due to iritis.

These are the only two which can be considered definitely preventable, and even they were not certainly irremediable. There was a prospect of later improvement by iridotomy, for which, however, the patients never returned.

If, however, we add what we know of the later results, we have to record three total losses—two cases of irido-cyclitis, which also destroyed the fellow eyes by sympathetic involvement, and a case of chronic cyclitis, with probable detachment of retina. The sympathetic cases are mentioned again on p. 287.

The four certain losses by intraocular hæmorrhage all occurred during 1906. This was a very heavy proportion, judging from our earlier experience. One of the eyes was glaucomatous—secondary glaucoma, due to traumatic cataract, with subluxation of the lens. Another eye was highly myopic.

Poor and Fair Results = vision less than $\frac{6}{60}$. Total 78 = 6·2 per cent.

In 1906 these results were considerably fewer than in 1905, including only twenty-seven out of the seventy-eight cases, or 4·2 per cent. of the total operations for the year.

The comparatively poor results of 1905 are largely accounted for by the fact that the practice of early needling had not then been instituted at the C. J. Hospital. There were eighteen defective visual results attributable to after-cataract in 1905, and only four such in 1906 (due to cortex alone or with blood remains). In eight cases in 1905 and in two cases in 1906 the

cause of the defective sight was not ascertained. This was due to neglect by the assistants of the hospital rule that cylinders were to be used in all cases where spherical lenses failed to give $\frac{6}{60}$ vision. The rule was that cases which still failed with cylindrical lenses were to be examined by me.

The remaining sources of imperfect vision nearly all dated from before operation. They included: Corneal opacity, 17 cases; vitreous opacities, 5; choroidal atrophy, 3; glaucoma, 4; occluded pupil, 4; traumatic cataract, 2; squint, 1. Other causes were connected with the operation: Iritis, 2; detachment of retina, 2; prolapse of vitreous, 1; prolapse of vitreous and of iris, 1; (?) fundus hæmorrhage, 1. Three other patients appeared to be simply of too defective intelligence to respond to the tests.

CHAPTER V

AFTER-COMPLICATIONS

The infective processes and non-infective reactions—Various forms of corneal opacity—Exfoliation of corneal epithelium—Anteflexion of the corneal flap—Filamentous keratitis—Conjunctivitis—Acute dermatitis—Spastic entropion—Prolapse and incarceration of iris—Prolapse and loss of vitreous—Impaction of capsule — Intraocular hæmorrhage — Delayed union and reopening of the wound—Transient detachment of the choroid—Mental disturbance — Flatulent distension of the abdomen — Secondary glaucoma—After-cataract—Detachment of retina.

THE INFECTIVE PROCESSES AND NON-INFECTIVE REACTIONS.

The **Infective Processes** constitute by far the most important departures from the normal course of events after operation. They are the most frequent cause of partial or complete failure to restore sight, and often also of greater or less destruction of the essential tissues of the eye. Besides the actual entrance of pathogenic bacteria of varying degrees of virulence, factors influencing the grade and extent of inflammatory reaction are those affecting the vitality of the tissues. The danger of operating upon the eyes of patients in the later stages of diabetes or nephritis is well recognized. And one can scarcely expect the tissues of patients presenting extreme anæmia from any cause to withstand infective organisms. But experience shows that only such readily recognizable constitutional conditions predispose markedly to pyogenic

invasion. Locally the resistance to bacterial invasion may doubtless be lowered by excessive traumatism, but this factor is rarely evident. The open door provided for the later admission of infective material by prolapse of iris or of vitreous has been already alluded to, and is mentioned again later. The mere bursting open of the wound after closure is claimed to admit infection sometimes. Owing to the reduced intraocular pressure after evacuation of the chamber, organisms are supposed to be sucked into the eye.

The most severe examples of the effects produced are grouped as **Suppurations.** Starting either as corneal wound infections, or as general intraocular invasions, they culminate in panophthalmitis. The deep infections soon give rise to ring abscess of the cornea. The signs and symptoms are generally pronounced within twenty-four hours. There is severe pain, much inflammatory swelling of conjunctiva and eyelids (that of the margin of the upper lid being well marked), with semi-purulent conjunctival discharge lying about the borders of the lids. The edges of the wound may or may not be infiltrated, yellowish, and swollen. The corneal surface is often steamy, and the iris and pupil are covered with dirty lymph. In spite of all treatment the inflammatory conditions rapidly intensify. Fibrinous and purulent exudation accumulates in the anterior and posterior chambers, and in the vitreous, distending the eyeball and opening the wound; and where the wound itself is directly invaded, suppurative destruction of the cornea spreads from it. These most intense cases are quite hopeless from the start; but there are other deep infections which begin rather less acutely, and hang for some days apparently in the balance. And there are rare destructive inflammations, which begin later, possibly several days after operation, in which the

infection gains access to the eye in some way after operation.

In one of our suppurations everything went well, with easily dilated pupil and but little injection of the eye, until the case was transferred, five days after operation, to another ward, where some patients were being treated for conjunctivitis, preparatory to cataract extraction. The next day the eye became inflamed, and in a few days had advanced to panophthalmitis.

Less intense infections are seen as severe **Irido-cyclitis.** One may be in doubt at first whether the case may not end in panophthalmitis. Short of this, many cases end equally badly so far as vision is concerned—in atrophy of the globe. And there may be sympathetic implication of the other eye. Still other inflammations respond to treatment, and subside with retention of useful vision in the eye. Early pain, complained of spontaneously by the patient at the surgeon's first visit, on the day after operation, is a particularly threatening symptom. On inspection there may be already a trace of yellowish white exudation seen at the margins of the pupil and coloboma, and the surface of the iris presents a very blurred appearance.

A lower grade of intensity is seen in the cases classed usually as **Iritis** simply, though doubtless the ciliary body is also more or less involved in the process. Though not very threatening in appearance at first, these inflammations may persist in spite of treatment, ending, perhaps, in closed pupils. Still, in treated cases, at least, the eyeballs do not usually soften. There is a prospect of later restoration of more or less useful vision by secondary operation. The only two cases of sympathetic ophthalmia, which we know to have happened after our Bombay operations, followed upon inflammations classed as simple iritis (one

case was not even regarded at the time as iritis), but the inflammations were neglected.

The symptoms usually set in several days after operation. Possibly, as a rough rule, the later the onset the milder the inflammation. There is pain, perhaps more at night, and usually lacrymation, slight lid-swelling, and more ciliary congestion than usual. But in feeble, sickly persons there may be a quiet outpouring of lymph, with very mild or no symptoms. I noticed an alarming amount of quiet exudation, but rapidly reabsorbed, in a few anæmic patients operated upon. In our experience some degree of muddiness of iris and of pupil is to be found in the majority of cases on the day following operation. And probably vigorous treatment with atropin and mercury, begun at once, prevents many inflammations from developing. Of the many early threatening appearances which have resolved under treatment, it has been impossible to decide how far the signs of exudation have represented infective agency, and how far simply reaction to traumatism, irritation from lens débris, etc. We attributed our comparative exemption from closure of the pupil due to iritis largely to exceptionally vigorous after-treatment, and not solely to the measures for guarding the wounds from infection.

In our work focal illumination after twenty-four hours showed comparatively few clear and active pupils, with bright iris. There were degrees of reaction culminating in a pupil largely occupied by, and in thickened iris partly hidden by, lymph mixed with blood remains and lens débris. And it often took several days' free use of atropin, morning and evening, to obtain fair dilatation of the pupil. In general the exudation was not added to upon the following days. On the contrary, absorption took place, though it was sometimes slow and incomplete. And pain and lacrymation remained absent. We

thought that some of these **Early Exudations**, even though quite transient, were due probably to the action of micro-organisms, in part at least. For it was impossible to distinguish them in the first day or two from other cases in which pyogenic action was shown by persistence of exudation and the onset of symptoms. Certainly, however, infective agency was not a very frequent source of this early transient exudation.

That the exudation was due mainly to irritation from minute particles of lens substance left behind, was shown by its almost sure absence after intracapsular extraction and after ordinary extraction of Morgagnian cataract.* The rarity of iritis after the intracapsular operation has been already referred to. It appears to apply to infective iritis. If this be so, the only obvious explanation is that contributory factors commonly play a large part in the development of infective inflammation. Cortical débris by irritating the iris probably leads to a deposit of fibrin, in which organisms may develop, and the lens substance itself may provide a suitable culture medium for pyogenic bacteria. Also possibly the additional strain placed upon the absorptive power of the eye may handicap the tissues in their struggle with micro-organisms. Among other local causes of early iritic reaction may be mentioned: (1) a varying degree of traumatism, especially bruising of the iris in squeezing the lens through a small section, also accidental pull upon the iris through movement of the eye or through badly cutting scissors, etc.; (2) prolonged irrigation of the anterior chamber, especially with fluid at an unsuitable temperature; and (3) reflex disturbance from an exceptional degree of surface irritation by the

* Yet beware of Morgagnian 'milk' left behind the iris. In two simple extractions we had early inflammatory glaucoma set up by it, through exclusion of the pupil.

perchloride. Also (4) injury to the eye during sleep, through ill-fitting bandage or screen; and possibly (5) slight reaction from adrenalin-constriction of blood-vessels, if excessive. Albuminuria, with some œdema about the ankles, and considerable anæmia, must be mentioned here as a constitutional condition exceedingly likely to lead to early exudation of lymph. Less likely causes are diabetes, gout, rheumatism, etc. The purely transient exudations are of importance only in so far as they form posterior synechiæ, preventing dilatation of the pupil, and more or less permanent after-cataract. It is scarcely necessary to remark that the formation of posterior synechiæ is very common after cataract extraction quite apart from the occurrence of iritis. Adhesions form readily between the edges of the capsular opening and the pupillary margin, and are particularly common after combined extraction at the projecting angles between pupil and coloboma. Some are due to imperfect absorption of blood-clot.

In a few of these early cases of muddy iris and pupil, after about three days the anterior chamber is found largely occupied with 'spongy' or 'gelatinous' exudate. That is to say, a semi-translucent deposit covering pupil and iris has begun to shrink. Perfectly clear iris can be seen at the periphery at one part, but elsewhere the iris, pupil, and coloboma are covered. The prognosis in these cases is good. The contraction of the exudate progresses rapidly under treatment, and any needful discission may often be performed in little over a fortnight from the time of operation.

Other exudations fail to clear up, and symptoms develop —pain, lacrymation, etc.—indicative of **Non-Infective Iritis**. Some degree of inflammation appears to be sometimes kept up mainly or entirely by lens matter. Though a large quantity of cortical matter may often be left behind,

with no effect whatever upon the iris, this is when the pupil is at once dilated. Probably then the capsule is for the most part interposed between the iris and the lens substance. But sometimes sufficiently rapid dilatation of the pupil is not secured, and the lens cortex lies in direct contact with the iris. The more irritating lens substance appears to be that of the more advanced cataracts. The worst in our experience is the milk of Morgagnian cataracts, but it is only rarely that any of this is left in the eye. Elliot (Madras) finds that lens cortex which swells up and "assumes a gelatinous appearance" is but little prone to set up adhesions, but that it is otherwise with stiff, unyielding cortex. Some slight cases of iritis may be due to injury by the patient's fingers, etc. Other persistent mild inflammations appear to be kept up sometimes by venous congestion, from constant coughing or from straining at micturition. Also constitutional taints, such as are capable of originating attacks of iritis apart from operation—gout, rheumatism, diabetes, nephritis, etc.—may be expected to give trouble at times. Again, the operation may serve to awaken old mischief.

In one case in which we operated upon an eye with occluded pupil, and in which a needling was performed afterwards, chronic iritis followed, with the formation of three probably tubercular nodules (see ' After-Cataract ').

Rarely corneal *wound infections* remain *localized*. The accompanying reaction is only very moderate, and the suppurative process can be arrested by suitable treatment. I remember one such case in which suppuration destroyed only a small portion of the corneal flap, not extending to its posterior surface.

Sympathetic Ophthalmia.—The only two cases in which we know that this complication followed cataract extraction performed by us in Bombay require mention here. One patient was discharged a month after operation seeing $\frac{6}{60}$ with a spherical lens. But she was still being treated with atropin

drops nine times a day, and with mercury internally. She insisted upon going home, though advised to stay longer. The extraction had been 'simple,' and followed by prolapse of iris, excised the next day. She returned four and a half months after the operation with pupil and coloboma completely covered with pigmented lymph. There was no ciliary injection remaining, however, and the eye was not soft, so that there appeared to be a possibility of later restoration of some vision. The fellow eye, sound at the time of discharge from hospital, was now practically destroyed by untreated inflammation.

The other patient was discharged twenty days after a combined extraction, seeing $\frac{6}{30}$ with a spherical lens. Atropin and mercury had been used in full amounts for a week only. After that time the mercury was omitted, and the drops used less frequently. The patient came back nearly three months after operation with both eyes quite hopeless.

In both of these instances there appears to be little doubt that the evil result might have been averted under more prolonged observation and treatment. In the second case there was no anticipation whatever of active mischief when the patient was allowed to go home.

A case of sympathetic inflammation ending in blindness has been reported by Zentmayer* (Philadelphia), following panophthalmitis after cataract extraction.

Late Infections occurring months or years after operation, through fistulous and cystoid scars, have earned an evil repute with respect to their proneness to cause sympathetic ophthalmia. We attributed our almost complete (apparent) exemption from these results to the broad conjunctival coverings over such incarcerations of iris and of capsule as were left in the wounds. I only remember one late infection. It was an acute case, iritis with hypopyon. But it subsided rapidly under treatment.

Treatment.—It is a safe rule in all cases where the iris is not perfectly bright and active on the day following operation, to endeavour to obtain immediate dilatation of the

* At the Amer. Med. Assoc., Ophth. Section, 1905.

pupil. Where there is much muddiness, as much atropin is instilled as seems likely to be borne without constitutional symptoms.* We commonly instilled the drops, 4 grains to the ounce, four or five times in the morning, with five-minute intervals, and a similar number of times in the evening. In these cases mercury should always be given at once also, either by inunction or by the mouth, or both. And it is perhaps advisable to begin with a dose of calomel, 3 to 5 grains, partly to act as a purge. Possibly in threatening cases intramuscular injections should be given for the first few days, after Schirmer.† His experience shows the great value of mercury in the case of infected wounds, both in controlling the local reaction and in preventing sympathetic involvement of the fellow eye. In Bombay we had emphatic evidence of the usefulness of the drug in this respect. After a few days, when the bandaging is stopped, dionin may be of assistance also, increasing the action of the atropin and helping in the absorption of lymph. Sodium salicylate, 60 to 90 grains daily, has been recommended in place of mercury. But there is not the same evidence in its favour. It is said that if sympathetic ophthalmia should follow in spite of salicylate treatment, it will be benign (Lindahl).

In the more threatening reactions subconjunctival injections should be used early. The benefit derived from them is often quite noticeable. It is recommended that if a subconjunctival injection cannot be made on account of chemosis in acute inflammations, the needle should be inserted through the outer part of the lower lid near the orbital margin. Bourgeois (Rheims) injects ½ c.c. of 1 in 1,000 cyanide of mercury, and repeats it several times, night and morning, if necessary. In Bombay we have

* The assistants must be made responsible that general symptoms are not occasioned by the solution passing down into the nose.

† *A. f. O.*, liii, 1.

been satisfied with the more ordinary 1 in 2,000 solution on the few occasions upon which we have needed injections, and have inserted about 15 minims. Moissonier* (Tours) found common salt injections more efficacious than cyanide injections in one case.

In all cases of definite iritis or irido-cyclitis presumably infective, the administration of mercury should be pushed (unless there is some constitutional contra-indication) to 'touch the gums' within a week.

In all severe infections the coverings of the eye are removed, and the conjunctival sac irrigated with perchloride lotion, 1 in 5,000, twice a day. Hot fomentations are applied if they relieve pain.

The insertion of sterile iodoform in powder, and in small discs (soloids) and rods, into the anterior chamber has been tried in severe irido-cyclitis and in corneal wound infections. It was first used experimentally by Ostwalt (1897), and has been recommended by Haab and others. The benefit derived has not been very marked, and the treatment has not been very generally followed. Cohn† used iodoform pencils in four infected eyes with no noticeable result.

If the wound surfaces be infiltrated and panophthalmitis threaten, it is said that the process may possibly be arrested by cauterizing the infiltrated surfaces freely. Kuhnt has suggested scraping of the surfaces and covering with a strip of conjunctiva. Irrigation of the anterior chamber with warm cyanide or salt solution is also recommended.

Evisceration is held to be the correct procedure in panophthalmitis or suppurative irido-cyclitis; enucleation for atrophy following upon plastic inflammation. In the

* Tenth Internat. Congress at Lucerne, 1904.

† *Zeitschr. f. A.*, xiii, 1, 31.

milder inflammations which respond to treatment it is important to keep the pupil widely dilated as long as any ciliary injection remains. And the administration of mercury is continued also. A watch must be kept for the possible onset of secondary glaucoma.

Late secondary infections are treated upon the same lines as the early ones.

VARIOUS FORMS OF CORNEAL OPACITY.

The striated corneal opacity known as *striped keratitis* is seen the day after operation as parallel vertical grey lines in the upper half of the cornea, running down from the (upper) section. The streaks have been shown to represent ridges on the posterior surface of the cornea, due to œdema, and are commonly the result of bruising of the cornea in squeezing the lens through a rather small wound, or by the frequent introduction of instruments. They have been attributed also to tight bandages, and to intraocular irrigation. The affection usually clears off within a week without treatment.

Less often a diffuse cloud of opacity forms, apparently of similar origin to the striated condition, if one may judge by its position and equally transient character. Sometimes a central patch of corneal haziness develops, with or without streaks connecting it with the wound. These central patches occurred particularly often in our practice after subconjunctival extraction by Czermak's method, and were obviously due to damage of the endothelium of the cornea in the somewhat difficult expulsion of the lens The area of opacity was nearly always broken up by fine, clear interlacing lines into a number of smaller areas giving rise to an appearance very like that of broken-up soft lens cortex lying in the anterior chamber.

It would seem likely that the stripes running from the wound indicate bruising of the wound surfaces rather than injury to the posterior surface of the cornea, judging from the different appearance of the opacities unconnected with the wound.

There are other less common diffuse opaque areas (not broken up into sections) which appear rather later and tend to be permanent, and which represent *contact keratitis*. They are sometimes seen in cases of retarded union of the wound, from prolonged contact between lens capsule and cornea. The capsule and the pupillary margin of the iris may form adhesions to the cornea.

There are other fine lines to be seen fairly often, at the time of discharge from hospital, on the posterior surface of the cornea unconnected with the wound. I have not seen them described as yet. They are so fine that they require the corneal loupe and focal illumination for their examination, and so they may readily escape detection. Many of them crossing about the centre of the cornea, they may serve to reduce the visual acuteness. They are *fine, double-contoured, grey lines*, mostly slightly curved, of variable length, but ending within the corneal circumference. They thus closely resemble ruptures of Descemet's membrane, but, unlike them, appear to be only temporary, disappearing within a few months. I think we have seen them most numerous in cases where there had been earlier central corneal opacity. They are very variable in number and direction; both horizontal and vertical lines may be present together. I once noticed fine vertical lines on the posterior surface of the cornea at the close of the operation.

There still remains to be mentioned the permanent opacity which results from the introduction of sublimate lotion or other feebly caustic chemical solution into the

anterior chamber. Our unfortunate experience with sublimate solution in Bombay has been already described sufficiently.

Exfoliation of Corneal Epithelium.

A rough corneal surface from irregular shedding of epithelium is very common after operation under combined adrenalin and cocain. Even under cocain alone it is frequent unless care be taken to prevent drying of the surface before and during operation. It is, perhaps, induced also by much friction upon the cornea with lens expressors. It is not a matter of any importance.

Anteflexion or Eversion of the Corneal Flap

must be very rare as an occurrence taking place after closure of the lids and the application of the usual bandage. Oatman* reported such a case, found at the first dressing, forty-eight hours after operation. The conjunctiva was much contracted by scarring, and it was thought that the pull from the lower fornix must have opened the wound sufficiently for the flap to be caught against the border of the upper lid. The flap was replaced by manipulation with a probe under the closed lid. It united without inflammatory complications, and became highly vascularized. Glaucoma followed. See also Elliot's case mentioned on pp. 306 and 311.

Bending downwards *of the conjunctival flap* over the cornea is a rare occurrence. In one of our cases the flap appeared to be pushed down by swollen ocular conjunctiva. The displacement recurred repeatedly. The conjunctival flap is more likely to be carried down by escaping vitreous.

Filamentous Keratitis

is given by Knapp as a complication seen occasionally "by the end of the second week." I have seen it a few times, and attribute it to too free perchloride irrigation before operation. It occurred in one of our cases where the operation had to be deferred after only the puncture and counter-puncture had been made. Four fine filaments had formed on the upper part of the cornea two days later. There was also a patch

* *Arch. of Ophth.*, xxv (1906), 481.

of pseudo-membrane on the upper tarsal conjunctiva, and similar material binding together the swollen folds in the lower fornix (such a condition as leads to the formation of conjunctival 'bridges' and 'pouches'). The filaments lasted as long as the conjunctival membrane. Had the operation been completed, it would have been impossible to evert the upper lid early, and the condition of the lower fornix might have escaped recognition also. Thus the association between the corneal and conjunctival conditions would probably have escaped notice, and the cause of the corneal complication would not have been recognized.

Some years ago a patient of mine with ripe cataract in one eye had almost constant filamentary keratitis in that eye, and very little in the fellow eye. After trials of many forms of treatment, we were able to control the condition sufficiently for operation to be successfully performed, by the daily application of 1 per cent. silver nitrate solution to the everted lids for some little time before operation. Curiously, he remained free from the corneal affection until lately, when the second cataract was ripening. The filaments then reappeared, chiefly in the cataractous eye, and recurred constantly until the lens was extracted from that eye also. Since then I believe the corneæ have remained unaffected.

Conjunctivitis.

Inflammatory reaction to perchloride irrigation is marked by swelling of the conjunctiva and of the eyelids. But there is little discharge except in the rare cases, such as that above mentioned, in which probably the whole thickness of epithelium is destroyed over some portion of the conjunctival surface, giving rise to a pseudo-membrane. As already stated, there is often difficulty in deciding to what extent simple swelling is due to filtration œdema, and to what extent due to inflammatory reaction.

Persistent post-operative conjunctivitis is commonly associated with the presence of staphylococci. Abelsdorf and Neumann* found the *Diplococcus albicans tardissimus* in three cases. It may be a continuation of a chronic conjunctivitis

* *A. f. A.*, (1900) xlii.

imperfectly cured before operation, and may have been aggravated by bandaging, atropin drops, etc.

Whenever there is discharge, the patient should be encouraged to keep the eyes open as much as possible.

Acute Dermatitis.

Apart from atropin irritation, we have seen a few cases of acute inflammation of the skin of the lids and neighbouring parts. They were evidently due to the perchloride used in washing the parts. The complication is well recognized as indicating an idiosyncrasy. Yet in one of our cases both eyes were operated upon (at an interval), and the complication only occurred on the one side. Evidently the washing must have been more thorough on this occasion. In our cases there was no particularly noticeable associated conjunctival reaction. The sharply defined reddened area of skin had an erysipelatous appearance. The lids were quite stiff and swollen, and could scarcely be separated. Obviously bandaging was unnecessary. In two patients numerous bullæ formed. And in one of these cases the discharge from the bullæ caused an extension backwards of the inflammation over the scalp, and, entering the conjunctiva, produced a hypopion, evidently by infection through the imperfectly healed wound. The pupil dilated easily, however, and the final result was quite satisfactory.

Spastic Entropion

of the lower lid in old people, promoted by the bandage, may very rarely necessitate an early removal of the bandage, with, perhaps, the application of strapping to the lower lid for its relief.

PROLAPSE AND INCARCERATION OF IRIS.

Prolapse or hernia of iris is the *bête noire* of simple extraction; incarceration is a complication mainly confined to the combined operation. The base or pillar of a coloboma may enter the wound in a single layer, otherwise a knuckle or fold of iris becomes impacted.

Prolapse is generally found at the first dressing, twenty-

four hours after operation. An onset a few days later* is seen rather more after operation with conjunctival flap; the development may be very gradual where the sclero-corneal wound is open under the conjunctival flap. In any case an early incarceration may enlarge later. The distinction between a visible incarceration and a minute prolapse is almost inappreciable. Impaction between the deeper portions of the wound surfaces only is scarcely distinguishable clinically from mere adhesion to the cornea in the line of the wound. Even a small prolapse may include the whole breadth of the iris from base to pupil, the protrusion being correspondingly prominent. On the other hand, wider entanglements in the wound, including only the base of the iris, may remain but little elevated. After simple extraction the greater portion of the incision may become occupied by a very large prolapse.

The onset of the complication may be marked by more or less pain. I once saw spontaneous retraction of a minute prolapse.

I found the prolapse possibly an hour after the first dressing of the eye by the hospital assistant. The patient was removed to the operating room, and cocain instilled. The prolapse, which had not been seen by the assistant, and had therefore occurred at the time of the dressing or afterwards, had then disappeared, and the pupil was round and central.

Spontaneous reduction has been recorded after much longer intervals.

Causes.—(1) Prolapse of iris is the result which we fear most from reopening of the wound after closure. The wound may be burst open by external influence, as (*a*) by any accidental blow or pressure or friction upon the eye, by the patient's finger or by a pressure bandage, for instance;

* Rarely, when the healing of the wound is imperfect, prolapse of iris may occur considerably later, as in the case mentioned on p. 309.

(*b*) by pressure of the lids; (*c*) by movements of the globe. Also by coughing, sneezing, vomiting, straining at stool or at micturition, or in other muscular effort.

Even with the lid muscle at rest the elastic tension of the lids exerts some pressure, variable in degree, upon the globe, as may be seen especially in 'slack eyes' during operation. It may be sufficient in itself to cause slight gaping of a cataract incision placed at the lower corneal margin. This pressure may be greatly increased by contraction of the orbicularis, especially in prominent eyes. By sudden violent closure of the lids, a wound at the upper corneal margin may be forced open, because the pressure upon the globe is increased unevenly. The pressure of the marginal bundles of the orbicularis as they come together is applied below the horizontal meridian of the cornea. The inequality of the pressure is greatest when the elastic tension of the lids is least, as in some old people. Similar contraction of the orbicularis is excited by any pain in the eye, also by a tight bandage, and is said to occur in coughing, sneezing, etc. Uneven pressure upon the eye by the lower lid only may be brought about also in dressing the eye if the upper lid alone be raised.

Extreme movements of the globe, especially in the vertical direction, occurring only with the eyes opened, tend to separate the wound margins by the pull of the muscles and by increase of ocular tension through the pressure of the muscles. Opening of the wound is thus sometimes seen during operation.

Increase of tension may also possibly occur by venous stasis in coughing, straining, etc.

On any sudden reopening of the wound after simple extraction, as insisted upon by Fuchs and Swanzy, the iris may be carried into the wound by the aqueous lying behind it in the posterior chamber, for the fluid makes directly for the wound by the shortest route, instead of passing around through the pupil into the anterior chamber. A narrow coloboma well up to the base of the iris is sufficient to guard against this. But even with the chambers empty, on any increase of tension together with gaping of the incision, the pressure of the

vitreous may suffice to force iris into the wound. This is well seen during operation in cases of so-called vitreous tension. The vitreous itself may or may not become prolapsed with the iris.

Where the deep incision remains gaping under a conjunctival flap, the iris sometimes slowly finds its way between the wound surfaces.

In simple extraction damage to the sphincter of the pupil by the knife or by the passage of the lens is a great predisposing factor. An active pupil is usually an effective safeguard. And in combined extraction removal of an unnecessary large portion of the pupillary zone of the iris with its sphincter muscle—whether by scissors or accidentally by the knife—predisposes to prolapse, as also does imperfect replacement of the pillars of the coloboma. This replacement may be impracticable when the iris is carried into the incision by escaping vitreous.

The swelling of lens cortex left behind the upper part of the iris is held to be at least a contributory cause of prolapse.

Some Percentages of Prolapse reported by Various Operators.

Author.	After Simple Operation.	After Combined Operation.	Number of Cases reported upon.
Little	19·00	—	106
	—	0·30	322
Swanzy	—	1·13	354
Schweigger ...	7·90	—	451
Galezowski ...	0·50	—	200
Drake Brockman ...	11·79	—	1,169
Moorfields results (Marshall) ...	13·87	—	267
	—	0·87	1,091
My own results ...	8·37	—	490

Consequences.—The most serious effect of a prolapse which is allowed to remain is a permanent liability to

bacterial invasion of the eye. But the degree of risk undoubtedly varies with the exposure of the protruded iris. It may lie bare, or may be partly or entirely covered with conjunctival flap. We noticed in Bombay that with a large exposure of iris there was often some iritis from the first, the enlarged and distorted pupil being at once occupied by a thin layer of lymph. This was, perhaps, especially to be expected in Indian practice owing to the general prevalence of chronic conjunctivitis. When the prolapse was quite small or, if large, completely covered by conjunctiva, the iris and pupil generally remained perfectly clear throughout. And from a large experience of subconjunctival prolapse intentionally produced in the treatment of chronic glaucoma, we learnt that a large degree of permanent protection against infection was afforded by the conjunctival covering over the weak scar. Though a bare prolapse becomes soon covered by epithelium, the layer is possibly thinner than that persisting from a covering conjunctival flap, and therefore more likely to become abraded. Thus the remains of uveal tissue may become exposed, there being no conjunctival and subconjunctival connective tissue beneath the epithelium. Hence the occurrence of late infective inflammations, either acute and suppurative, possibly ending in panophthalmitis, or chronic and insidious, and possibly more serious than the acute cases, leading to sympathetic involvement of the fellow eye.

An exposed knuckle of iris becomes quickly covered with lymph and adherent to the surfaces of the opening through which it has escaped. As the union becomes consolidated the extruded iris gradually loses much of its pigment, becoming changed into more or less pervious fibrous tissue. Quite small protrusions often flatten down within a few months without cicatrizing firmly. A more

or less fistulous or filtering track forms, through which some aqueous passes, often reducing the ocular tension slightly.

As a final result of a small subconjunctival protrusion there is more or less œdema of the neighbouring conjunctiva. Often a sharply defined pale, transparent vesicular patch of conjunctiva, a *filtration area*, develops over and around the remains of iris, which is seen as a dark underlying point. The patch is 2 or 3 millimetres or more in breadth, more or less unevenly elevated, and in dark and yellow-skinned races generally sharply outlined by the dark colour of the surrounding conjunctiva, intensified by an accumulation of pigment washed out of the vesicular area. This represents the typical subconjunctival *fistula*. There are other smaller opaque grey elevations, formed evidently by the union of the conjunctival covering with the loop of iris. Some of these, evidently filtering more freely than the rest, present dark centres bordered by narrow whitish rims (of sodden epithelium ?).

Large prolapses commonly persist without appreciable diminution in size, changing to a greyish colour by loss of pigment and by union with overlying conjunctiva. The neck of the protrusion, however, evidently tends to contract as regards its internal—not its external—surface. For, on laying open the cavity of the staphylomatous prominence, there may be no immediate drainage of aqueous from the anterior chamber. The term '*cystoid cicatrix*' is applied sometimes to these staphylomatous scars, at other times to smaller prolapses with vesicular conjunctival coverings. If used at all, the term should be restricted to the former class of case.

Displacement and distortion of the pupil result from the drawing of the iris upwards, the degree of these defects varying with the width and elevation of the prolapse. A

small but prominent prolapse, including the whole breadth of iris, may draw the pupil quite up to the cicatrix, narrowing it also. Increase in width of the pupil with less complete displacement may result from a wider inclusion of the base of the iris. In the case of a very extensive prolapse the lower margin of the greatly stretched pupil may rise well above the horizontal meridian of the cornea. I have had to perform iridotomy on this account.

Depending mainly upon the extent of the incision occupied is the degree of forward displacement of the corneal flap and consequent *astigmatism*. A quite localized protrusion of the whole breadth of iris may have little or no effect upon the corneal curvature, while an extended inclusion of the base of the iris may cause considerable flattening. The astigmatism is often irregular, and therefore only partly corrected by cylindrical lenses. By a very large prolapse the upper part of the cornea may be bent forward instead of backward, a fine transverse grey line on the back of the cornea marking the lower limit of the abnormal curvature.

A prominent staphyloma is not only very disfiguring, but tends to keep up chronic *conjunctival irritation*. The bulbar conjunctiva on either side of the elevation is no longer cleansed by the movement of the lids over it.

In ophthalmic literature references to secondary *glaucoma* resulting from prolapse and incarceration of iris are so frequent as to convey an exaggerated impression of the closeness of the connexion. I have rarely known high tension together with inclusion of iris visible externally. The tendency is to the development of low tension by filtration of aqueous through the weak scar. Possibly in some cases this may be prevented by impaction of

vitreous* together with iris in the wound. In other cases the high tension may be only temporary. In treating chronic glaucoma by subconjunctival prolapse I found that in some eyes a period of high tension, lasting possibly two or three months, supervened before filtration was established. But these were eyes in which the iris was tough and rigid from old glaucomatous changes.

Treatment.—If a small prolapse be seen very shortly after its onset, replacement with a spatula, followed by eserin instillation, is probably indicated. But when the prolapse is found simply at the daily dressing of the eye, and the iris has been exposed in the conjunctival sac possibly for hours, its reduction is objectionable, lest adherent infective organisms be carried into the eye. Immediate excision is the only correct treatment. It is often, however, by no means easy. The congested loop of iris is hyperæsthetic, and is rendered only partially insensitive by cocain. The use of a stop-speculum and fixation of the eye are both inadmissible, lest loss of vitreous be brought about.

It is generally considered necessary or advisable to perform the small operation under general anæsthesia; and this is the great drawback to the treatment. The risk of loss of vitreous or possibly of intraocular hæmorrhage from vomiting after the anæsthetic must be considered. But I have never found general anæsthesia necessary. Adrenalin is instilled twice, and is followed by cocain, 4 per cent. solution, four times at somewhat prolonged intervals, so that twenty minutes in all is taken up. If there were still any trouble from pain excited by seizure of the iris, the application of a few crystals of

* Otherwise, how is it that prolapse or incarceration of iris in a sclero-corneal wound may be relied upon confidently to relieve primary glaucoma?

cocain should be of service. I only remember once causing a small escape of vitreous in removing a prolapse, and that was with the help of cocain alone, without adrenalin. Before the instillation is begun irrigation of the conjunctival sac with perchloride is indicated. (We used 1 in 3,000, drop by drop, for one minute as a rule.) The lids are firmly separated by the assistant's fingers, or, if this prove insufficient, Desmarres' retractor is used for the upper lid, with finger depression of the lower lid. Straight toothed iris forceps are used for seizing the iris; or, if curved forceps be used, their points must be directed upwards, so that they cannot possibly enter the wound in case the eye rolls up. The eyeball is very likely to turn upwards when the iris is pulled upon. The tissue must of course be released at once, and, if the lids be firmly held, no harm ensues. If the iris is covered by conjunctival flap, the latter must first be peeled off, a separate pair of forceps being used for this purpose.

This peeling of the conjunctival covering may be accomplished much later after the cataract operation than one would expect. I did it once as late as seventeen days after the cataract extraction for removal of a small late prolapse, which had appeared gradually. In this case some bleeding occurred into the anterior chamber, and the chamber did not become re-established for some days afterwards. Conjunctiva can ordinarily be separated from underlying iris as late as four or five days at least after the formation of the prolapse.

In dealing with a small or moderate protrusion the iris is pulled out through the opening sufficiently to remove the whole of the tissue which has been nipped in the canal. It is snipped off with de Wecker's or other scissors pressed down upon the wound margins. If the removal be done early, within twenty-four hours of the occurrence of the hernia, the pillars of the coloboma

made should retract well away from the wound, leaving no adhesion. But if the treatment be delayed for another day or more, infiltration will have spread into the neighbouring iris, and permanent adhesion between iris and cornea will form near the wound. One cannot expect to remove the whole of a very extensive prolapse, but the greater portion of it can be cut away in one snip without pulling upon the iris at all to attempt to free it laterally. Though incarceration of iris is left at either end, the result in my experience is a flat cicatrix. A certain amount of retraction appears to take place, even though atropin be instilled for slight iritis.

After the small operation sterilized eserin drops may be instilled if the pupil and iris are quite clear; otherwise atropin may be required for threatening iritis, and should be used freely and unhesitatingly.

It cannot be said that the result of the treatment is always satisfactory. Infection* may have already entered the eye, or may gain admission at the time of the excision. Adhesion of iris to the scar may lead to secondary glaucoma, or the weak scar left after partial excision of a large prolapse may entail a permanent though small risk of late infection. At best, after protracted healing, causing anxiety to the patient, a broad and disfiguring coloboma may be the result, causing dazzling and defective orientation. Kuhnt recommends the covering of the site of the prolapse by a bridge of conjunctiva.

Rarely treatment may have to be deferred for some reason.

For instance, in one of our cases acute dermatitis with serous exudation from perchloride irritation rendered early excision of a subconjunctival prolapse inadvisable. And the dermatitis persisted until it was too late to separate the conjunctival flap.

* In one of our cases both eyes were lost later by sympathetic ophthalmia.

And one may feel reluctant to undertake so troublesome a treatment for a minute subconjunctival incarceration or prolapse, especially if the complication arises late and gradually; and after loss of vitreous it appears altogether too risky. One hesitates even to perform the small operation where the lens has been extracted in its capsule without loss of vitreous; also, perhaps, where vitreous tension has been very evident during ordinary extraction. It is, perhaps, hardly necessary to mention that any operative treatment of a prolapse should precede that of after-cataract, in case the latter should also be required. Should the order of procedure be reversed, loss of vitreous would be very probable when the prolapse was excised.

The main object of later treatment is the reduction of the liability to late infection. In some cases also disfigurement is removed and corneal astigmatism lessened. Of small low protrusions only those uncovered by conjunctiva would be interfered with. I have several times cut away as much as possible, and covered the site by a band of the neighbouring conjunctiva, undermined and drawn down by a suture on one or both sides of the cornea. The accurate fixation of the conjunctival strip requires care. In the case of a prominent staphyloma it would appear perhaps wise to wait for a few months for partial closure of the neck communicating with the anterior chamber, and then to adopt Berry's treatment.* After freely laying open the 'cyst,' he cauterizes superficially the defective portion of sclero-corneal cicatrix in the expectation that the deep inflammatory reaction excited will consolidate the filtering tissue and lead to firm closure. The wall of the staphyloma is left as a covering to the cauterized tissue.

Simple cauterization has been recommended and carried

* *Trans. O. S.*, xxii (1902), 273.

out to produce flattening and condensation of the tissue of small elevations resulting from limited prolapse; but I believe it is wrong in principle. It does not disconnect the iris from the surface, and even exposes it afresh by destroying the epithelial covering. I have seen two late infections in my own practice following upon this treatment of prolapse.

Where an extensive prolapse has been allowed to heal in the wound, partial excision of the altered iris tissue may be combined with the application of a corneo-scleral suture to produce flattening and approximation of the wound margins, or with an attempt to cover the tissue with conjunctiva. In a few such cases, fearing the connexion of the uveal tract with the weak scar, I have afterwards separated the adherent base of iris at either side, by an irido-sclerotomy upwards.

Prolapse and Loss of Vitreous.

An extensive prolapse or incarceration of vitreous may be found at the first dressing, with or without similar involvement of the iris. Vitreous may have presented in the wound at the time of operation, or, on the other hand, everything may have gone smoothly then. Major Elliot (Madras) has sent me notes of several cases in which later prolapse occurred, including a wide prolapse found on the ninth day, a small one on the sixth day, and another bulging wound on the sixth day. Also of vitreous loss on the thirteenth day, due to anteflexion of the corneal flap by the upper lid in a case of delayed union of the wound. Most of the causes of prolapse of iris may also lead to hernia of the vitreous. On at least one occasion on the day following operation I have seen the distorted pupil characteristic of considerable vitreous loss, though no loss had occurred at the time of operation. Twice I have seen recurrence of vitreous escape—in one case at the first dressing twenty-four hours later, in the other case at the second dressing—from eyes which had lost much vitreous during operation. Both of these eyes became atrophic later, though there was moderate

vision in one at the time of discharge from hospital in spite of a retinal detachment.

Impaction of Capsule,

besides causing delayed union, may produce a permanently fistulous scar, with its infective dangers, or may induce glaucoma. I have not had personal experience of inflammatory troubles arising obviously from this source, and feel that they must be rare. Possibly in some of our infections ascribed to entanglement of iris associated impaction of capsule may have been equally responsible. Treacher Collins has examined microscopically three eyes in which entanglement of capsule in the wound had led, apparently, to irido-cyclitis, and in two of the cases to sympathetic inflammation of the fellow eye.

INTRAOCULAR HÆMORRHAGE.

Bleeding into the anterior chamber is to be expected occasionally within a few days after operation by sclero-corneal section. I have known it to occur more than a fortnight after operation (in a case complicated by slight iritis). It results from any strain upon the wound sufficient to break down some of the new tissue by which union is taking place. New blood-vessels form very rapidly from the episcleral tissue. The strain or injury may or may not be sufficient to reopen the wound. Thus occasionally the anterior chamber may be found emptied of aqueous and containing only a thin, uneven layer of blood. Much more commonly however the anterior chamber has either not been emptied, or if it has been emptied, has become refilled by closure of the wound.

The absorption is sometimes very slow. And organization of clot, producing after cataract, is to be expected frequently from this hæmorrhage, occurring at a time when the eye is irritable and when more or less exudation is often present. In some cases there are obviously

repeated hæmorrhages, the hyphæma being increased at intervals for some weeks. In some of these cases there is no obvious explanation of the persistence or repetition of the trouble. One of our patients, in whose eye blood remained for two and a half months, had diabetes and albuminuria. In another persistent case there was a troublesome chronic cough. The instillation of atropin is indicated to prevent synechiæ from forming, especially in cases due to external violence. In chronic cases dionin may help to promote absorption.

Much more rarely bleeding may take place behind the iris also, coming obviously from other sources, in part at least. There are cases intermediate in gravity between those just mentioned and expulsive retrochoroidal hæmorrhage.

Once, when I perhaps hurt the eye a little in dressing it three days after operation, the patient, an exceedingly nervous man, suddenly jerked his head away, and closed his lids so violently, that blood not only filled the anterior chamber, but also poured from the reopened wound, and became diffused through the vitreous. The fundus could not be seen even a few months later. Detachment of the choroid was diagnosed from a large lateral defect in the field of projection of light. Vision was practically destroyed; fingers could not be counted.

DELAYED UNION AND REOPENING OF THE WOUND.

Gaping of a sclero-corneal wound under a conjunctival flap has been sufficiently dealt with. It is not commonly referred to under the term 'delayed union.' But this designation is earned at least in the cases where the tension of the eye remains very low for weeks after the operation. Where this low tension is associated with obvious separation of the deep wound one does not

hesitate to ascribe it to drainage of aqueous through the wound, though there be no longer any noticeable general filtration œdema. The anterior chamber is frequently rather shallow, but not always so. In other cases gaping of the wound is very slight, and in still others it cannot be made out at all. These soft eyes without visible separation of the wound margins, and with partly or completely re-formed anterior chamber, were, I think, with us much commoner since we operated with an extensive conjunctival flap than when we placed the incision at the superficial sclero-corneal junction. And there does not appear to be sufficient reason to consider them separately from cases in which the deep wound gapes visibly, though there is always the possibility that the leakage may be between choroid and sclerotic, and not through the wound. And other explanations of the low tension have been suggested. For example, Czermak* suggested their relationship with so-called ophthalmo-malacia, and Chevallerau† explains a case of enophthalmos after operation as possibly due to a sympathetic lesion. I looked for choroidal detachment in several cases without finding it, but with after-cataract present the signs of this detachment may have escaped notice. I remember one such case several years ago, discharged from hospital with the eye soft after operation without conjunctival flap; the patient returned a few months later with a prolapse of iris occupying a portion of the cicatrix. There is a general feeling that an anterior chamber of normal depth, or deeper than normal owing to the removal of the lens, shows an absence of drainage through the wound sufficient to account for a tension – 2 or – 3. But that this is not so I have seen in glaucomatous eyes after the establishment of

* 'Die Augenärztlichen Operationen,' p. 944.
† *La Clin. Opht.*, 1899, p. 23.

wide subconjunctival fistulæ. It is uncertain how long the low tension may last. We kept one patient under observation for nearly a month after a Czermak's operation, and the eye was still very soft.

In the more generally recognized leakages through the wound the iris and lens capsule are in contact with the cornea. With us it has been much less frequent, and the chamber has remained empty for shorter periods, since we used a conjunctival flap. With purely corneal incisions the chamber more commonly remains empty from the beginning, so far as one can judge from single daily inspections. With a conjunctival flap it is recognized that early filling of the chamber is to be expected more regularly, but re-emptying of the chamber is, perhaps, rather more frequent a few days after operation. There may be hæmorrhage under the conjunctiva along the line of the wound, and in the anterior chamber. And blood in these situations is presumptive evidence of breaking down of early union, though the anterior chamber may have become re-established.

In corneal incisions a minute opening can sometimes be distinguished, a 'capillary fistula' through which the fluid escapes, due to entanglement of a shred of capsule, lens substance, vitreous, or iris in the wound. Sometimes a leaking wound is a consequence of a large incarceration or prolapse of iris or vitreous, or of separation of the wound margins by vitreous tension. Other cases in which the lips of the wound remain singularly free from signs of reaction and repair have been ascribed by Mellinger* to the too free use of cocain during operation.

Among other suggested explanations may be mentioned an uneven incision, too frequent disturbance by dressings, entropion, and defective reparative power peculiar to the

* *Beit. z. Augenheilkunde*, Basel, 1893.

patient. This latter is suggested by the occurrence of the complication in both eyes, or in two operations on the one eye (*e.g.*, in a preliminary iridectomy and in the subsequent extraction operation).*

The leakage commonly ceases within a week or two, but considerably longer delays have been recorded. A. Terson reported one lasting a month and a half. And the formation of a broad anterior synechia may prevent re-formation of the chamber after the drainage of fluid has stopped and the tension of the eye risen.

It is curious that the complication seldom leads to evil consequences. Invasion of corneal wounds by pyogenic organisms is probably prevented by the surfaces becoming covered with epithelium, and by the flow of fluid from within the globe. But infections have been recorded.† Prolapse of iris may occur, in eyes other than those with sclero-corneal incision gaping under the conjunctiva. Also anterior synechia, with consequent glaucoma and possibly extensive corneal opacity (contact keratitis). And one fears lest downgrowth of corneal epithelium into the anterior chamber should give rise to glaucoma by blocking the filtration angle. Elliot‡ (Madras) relates a case in which the patient turned down the corneal flap with his lid on the thirteenth day, causing a free vitreous escape. A median suture was applied several days later to the bulging wound.

In the large majority of cases nothing is required in the way of treatment beyond continued bandaging of the eye without pressure, till the anterior chamber refills. The merely soft eyes, with the chamber normal or nearly so, appear to require simple protection from injury by a

* Harlan, *Ann. of Ophth.*, vii (1898), 568.

† See, for example, Czermak, 'Die Augenärztlichen Operationen,' S. 940; Barck, *Amer. J. of Oph.*, 1897, p. 281; Maynard, 'Manual of Ophthalmic Operations,' p. 112.

‡ Personal communication.

shield, more particularly at night. Light stimulation of the wound surfaces with silver nitrate or iodine solution has proved effective for obstinately leaking corneal wounds. Also cauterization, and freshening of the surfaces by the introduction of a spatula. These measures may serve to destroy or remove shreds of tissue incarcerated in the wound. Massage of the cornea has been tried. Iridectomy has been successfully employed, and not only in cases when the iris was involved in the wound. Possibly it acts by freshening the wound surfaces. Entropion may require operation or the removal of the bandage. Sometimes when the chamber is re-established after being long absent, the wound margins may not be found in good apposition. And the continuance of (pressure) bandaging may be required on this account.

Transient Detachment of the Choroid

after cataract extraction, first noticed by Knapp in 1868, has been studied especially by Fuchs.* It is rather a pathological curiosity than of clinical importance, since the sight is only very temporarily affected. It is associated with low tension of the eye and a shallow or empty anterior chamber, which may have persisted since the operation, or may have reappeared. These clinical signs may precede recognizable separation of the choroid by an interval of a day. The detachment dates commonly from the second to the eighth day after operation, but it may come on some weeks, or even months, later. It may be so prominent as to be seen by focal illumination. On the other hand, it may not be discernible even on ophthalmoscopic examination, owing to the presence of blood or cortex in the pupil. And a shallow separation readily escapes detection, since the separated portion is of the same red colour as the rest of the fundus. It is recognized by the dark curved line marking its posterior boundary, with bending and parallactic movement of the retinal vessels. In these low detachments, especially soon after their onset, there may be folds concentric

* *A. f. O.*, li (1901), 2, 199.

with the curved posterior margin. As a general rule, the elevation, if low when first seen, remains low. Sometimes both the development and the subsidence of a large detachment are very rapid. The disappearance generally coincides with refilling of the anterior chamber and rise of the tension to normal. The duration of the detachment is commonly only a very few days, but it may be a month.

The site of the separation is mainly at one or both sides of the eye. Both sides are, apparently, not often equally affected. Detachments above and below only occur associated with more prominent lateral ones. They are much less frequent than the latter, and are always shallow. Separation does not take place readily further back than the points of exit of the venæ vorticosæ.

Fuchs attributed the complication to the passage of aqueous into the supra-choroidal space through minute rents in the soft tissues at the angle of the anterior chamber. The fluid in the space has also been regarded as a purely passive serous accumulation,* depending upon low tension in the eye, the latter being brought about by drainage through an imperfectly united or reopened wound.

Other more lasting, and possibly permanent, choroidal detachments occur rarely from hæmorrhage during or after extraction. See, for example, the case mentioned on p. 308. Possibly limited supra-choroidal hæmorrhages pass unnoticed.

Mental Disturbance.

Cataract operations are occasionally followed by various forms and degrees of mania, with hallucinations, or by simple confusion of mind, or by noisy and violent delirium, in which the patient is restrained with difficulty from pulling off his dressings. The mental equilibrium of some old people is upset by having both eyes bandaged, or by confinement in a very dark room. In alcoholic subjects delirium tremens is a possibility. But in some cases no explanation has been available beyond the mere influence of the operation. Fromaget† suggests auto-intoxication as a cause.

* Thomson Henderson, *Ophth. Review*, xxvi (1907), 191.

† *Ann. d'Ocul.*, cxxiii (1900), 183.

In two cases he connected delirium with reduced secretion of urine and constipation. Finlay* reported a similar observation connecting the delirium with renal insufficiency. It may come on early or late, most often after a few days. Most cases yield to treatment, such as the admission of light and the administration of sedatives. But a few patients have become permanently insane, and deaths have occurred. Care must be taken to prevent injury to the eye so far as possible.

The only troubles of this sort with which we had experience in Bombay were cases of atropin poisoning years ago, when ordinary precautions were not taken by the attendants in instilling the drops.

Flatulent Distension

of the abdomen is very commonly found in India, especially in private patients, the day after the operation. The patient has generally passed a sleepless night, and often has pains in his loins. These troubles are due to the patient having lain on his back, afraid of the smallest movement, thinking that his eyes might be injured thereby.

SECONDARY GLAUCOMA.

Glaucoma follows the operations of cataract extraction and of needling for after-cataract in a small percentage† of cases. It may set in at any period. A sudden rise of tension may develop within twenty-four hours after discission.‡ A slower elevation of tension may mark the consolidation of the cicatrix a few weeks after extraction of the lens, or may be found as the cause of a gradual deterioration of vision years later.

It is impossible to deny that some of the glaucoma seen after these operations may be primary, the association

* *Arch. of Ophth.*, xxxiii (1904), 5.

† Marshall gives a percentage of 2·08 in secondary operations at Moorfields.

‡ Very rarely at such an early period after cataract extraction, and then only by exclusion of the pupil.

between the condition and the operation being fortuitous. But in many cases the causal relationship is unmistakable.

Glaucoma may have been present in the eye before operation. Or the primary nature of subsequent glaucoma may be suggested by the same condition occurring in the fellow eye, if, moreover, the operation and healing of the wound has been uneventful; more especially if there is neither incarceration of iris or capsule in the scar, nor adhesion to the scar, and if the interval between operation and the recognition of tension is long.

The secondary nature of the affection may be attested clinically by anatomical conditions known to be effective, or may be suggested by almost immediate onset after operation. And the greater frequency of the complication after combined extraction than after simple extraction is evidence of an etiological relationship.

Where the complication supervenes upon cataract extraction supplemented by quite early discission, there may naturally be some doubt as to the relative parts played by each operation as causative factors. So far as the evidence goes, discission cannot be considered accountable for any glaucoma which is not of early onset, unless it be through the instrumentality of an iritis or irido-cyclitis.

It is, of course, possible that a predisposition to primary glaucoma may combine with some result of operation in the development of the complication. But the conditions clinically recognizable as predisposing to primary glaucoma—shallow anterior chamber, small cornea, hypermetropia—can have little influence in this relationship. Indeed, one may suppose that the deepening of the chamber from a satisfactory lens extraction may at times serve as an efficient prophylactic against the onset of glaucoma.

Much of the high tension met with after either the major or the minor operation is inflammatory in origin. Various forms and degrees of iritis and irido-cyclitis may act here as they do quite apart from operation, either through annular posterior synechia excluding the pupil, or more commonly by the accumulation of albuminous

fluid and exudate and the blockage of the filtration channels.

Interest, however, centres more in the development of high tension quite apart from inflammatory changes or insufficiently accounted for by them. After cataract extraction incarceration of iris or capsule, or both, in the wound has been most frequently blamed. Besides the obliteration of the filtration angle at the actual site of the impaction, broad or narrow, there may be extensive adhesion between base of iris and cornea in the immediate neighbourhood. This is owing to localized changes of inflammatory nature, excited around the impacted tissue, and spreading more or less to the neighbouring iris. The forward displacement of the iris to the line of the scar, especially where the wound has been purely corneal, may be sufficient to narrow the whole circle of the filtration angle.

In cases of chronic iritis it may be impossible to apportion the influences of inflammation and adhesion to the line of the scar. As the inflammation persists, and as fibrous tissue replaces the proper iris tissue, the drawing forward of the iris becomes more marked.

Glaucoma is more common after combined extraction because of entanglements of the tissues in the wound, and also of mere adhesions to the cicatrix. Here the extent of the adhesions and the position of the wound-line (purely corneal or sclero-corneal) are important considerations, for it is comparatively rarely that forward displacement of the root of one or both pillars of the coloboma may not be found on focal illumination after the combined operation. In a glaucomatous eye whence the lens had been removed in its capsule Treacher Collins once found adhesion of hyaloid membrane to the scar accountable for closure of the filtration

angle. This may possibly result from any vitreous prolapse.

Inclusion of a tag of iris or capsule in the wound may also be responsible for (1) delayed refilling of the anterior chamber, and possibly (2) downgrowth of surface epithelium into the anterior chamber. Later there may be (3) "a continual drag upon the ciliary processes, exaggerated by the perpetual movements of the iris and ciliary muscle. In this manner ciliary irritation is set up."* The empty chamber must obviously aid in the formation of peripheral anterior synechiæ.† The downgrowth of corneal or conjunctival epithelium may be so rapid as to cover the whole depth of the wound surfaces in four days. It may extend to line the anterior, and even the posterior,‡ chamber completely, perhaps closing the pupil and coloboma, or it may be confined to the neighbourhood of the wound, obstructing the filtration angle. The layer covering the iris, or actual cyst-formation, may or may not be visible clinically.

It has been suggested that cortical remains may cause glaucoma (1) by irritating the iris and ciliary body, and so causing increased secretion; (2) by blocking the spaces leading to the canal of Schlemm; and (3) by swelling sufficiently to press forward the root of the iris. Intraocular hæmorrhage occurring after the wound has united has been mentioned also as a possible source of tension.

A sudden rise of tension after discission (said to be more common in cases where the extraction was without

* Parsons, 'The Pathology of the Eye,' iii, 1083.

† Our three Bombay cases of secondary glaucoma mentioned on p. 247, due to accidental irrigation of the anterior chamber with perchloride lotion, were probably brought about by peripheral anterior synechia. This would be permitted by destruction of the endothelial lining of the anterior chamber.

‡ Elschnig, *Kl. Mbl. f. A.*, xli (1903).

iridectomy) has been explained as the result of additional obstruction of filtration paths already restricted by sequelæ of the extraction operation. Reactionary swelling of the ciliary processes pushing the base of the iris forward may temporarily close an already narrow filtration angle, or some imprisoned cortical matter may be set free into the chamber, choking up the meshes of the pectinate ligament. Some cases in eyes with no obvious peripheral shallowing of the chamber appear to be explicable only by the advance of broken-up (perhaps abnormally fluid) vitreous to mingle with the aqueous.

In one such case of tension following the double-needle operation in a child in my practice, the presence of vitreous in the anterior chamber was shown by failure to empty the chamber on tapping with a narrow knife.

Bajardi's* production of plus tension in aphakic eyes of rabbits by injecting vitreous into the anterior chamber is interesting.

Knapp† and Dalen‡ depict the persistent forms of glaucoma following discission as more or less inflammatory, with forward protrusion of iris, and presumably seclusion of the pupil. But many of these cases with bulging iris are certainly not entirely or mainly due to general iritis or irido-cyclitis. For there may be little or no exudation visible binding down the pupillary margin to the capsule, and the signs of seclusion may set in within twenty-four hours—far too rapidly for the formation of annular posterior synechia from general iritis. The suggestion that these appearances may represent incarceration of vitreous in the pupil, kept small by spasm of the sphincter, appears a little strained. A case of my own throws some light on their origin. On the day following a simple extraction of a Morgagnian cataract, containing fluid of unusually thick creamy consistence, the eye was painful and injected, pupil small, and anterior chamber not refilled. It was not till

* *R. Acc. di Med. di Turino*, Luglio, 1896.

† *A. f. A.*, xxx (1895), 8.

‡ *Mitteilungen aus der Augen. Klinik in Stockholm*, 3 Heft, Jänner, 1901, S. 75.

another day had passed that the tension was tested and found to be high. The tension and the pain were relieved at once by a simple puncture through the iris. There was undoubtedly exclusion of the pupil, brought about by the irritation of the creamy lens débris. It had been noted at the cataract operation that a little of this material repeatedly crept into the pupillary area from behind the iris even after free irrigation of the anterior chamber. And doubtless some trace of it remained behind. It is worthy of note in this connexion that after Knapp's simple extractions with 'peripheric splitting' of the capsule, the reopening of the capsular sac by the needling is very likely at times to set free imprisoned, overripe, irritating cortical remains. This form of glaucoma appears to be the only one which can arise thus early after cataract extraction—*i.e.*, in an eye with a large recent wound. It can scarcely happen after combined extraction. (In Norris and Oliver's 'System,' iv. 392, mention is made of the fact that early onset of glaucoma is seen more after simple than after combined extraction.)

Treacher Collins has found adhesion of capsule to the site of a needle puncture as an additional cause of glaucoma. Clinically, it is, I believe, not rare long after discission through a corneal puncture to see a fine grey thread running back from the minute corneal scar. But presumably these threads are mostly the remains of altered vitreous.

Cases of very slow onset after cataract extraction, whether supplemented or not by discission—cases for which treatment is sought months or years later—are naturally often those in which the causes above given are least obvious, and in which, therefore, the presumption of primary glaucoma appears reasonable.

De Lapersonne believes renal impermeability to be an important factor in the causation of the plus tension.

Our notable exemption from this complication in Bombay, so far as cataract extraction is concerned, has been alluded to already. We considered it due largely to the use of the conjunctival flap, which not only led to the formation of many filtering cicatrices, but also ensured early refilling of the anterior chamber and prevented

downgrowth of epithelium. Important also has been the rarity of inflammatory complications. And satisfactory replacement of iris and capsule during operation, with retention of activity in the pupillary sphincter, must have had a definite prophylactic influence.

Knapp* says, "Glaucoma is the only consequence of discission which may be fairly considered as inherent to the operative procedure. A low degree of increase of tension appears not infrequently, perhaps, during the first twelve hours as reaction from the operation, and disappears without treatment."

The *treatment* of a malady of such diverse origin cannot be uniform. Many of the early cases, and particularly those excited by needling, subside under treatment by eserin. Dionin and both hot and cold applications have also been used. And Pagenstecher has recommended the administration of sodium salicylate. Even cases of inflammatory origin have been treated by eserin. But it is more rational to treat them with atropin, relieving the tension temporarily by paracentesis or sclerotomy. A prolonged reduction of tension may be secured by a modified subconjunctival paracentesis (see Fig. 95). Where there is exclusion of the pupil, transfixion of the pupillary membrane is indicated, possibly succeeded by iridectomy or iridotomy. For adhesion or incarceration of iris or capsule the mere division of these tissues may be sufficient, or it may be combined with sclerotomy (Narben-sclerotomie, Oulétomie). Or iridectomy may be preferred. For the late chronic forms of glaucoma either iridectomy or one of the newer operative measures appears to be indicated—Heine's detachment of the ciliary body, or the formation of a filtering cicatrix (Lagrange, Herbert), provided the

* Norris and Oliver's 'System,' iii, 816.

posterior capsule has not been punctured, allowing vitreous to come forward into the cicatrix. The prognosis is not always favourable, in so far as the condition may possibly be brought about through epithelial ingrowth, over which we have no control.

AFTER-CATARACT.

After-cataract is the term applied to the opaque tissues, mostly membranous, present in some degree in the pupil and coloboma after the very large majority of ordinary cataract extractions. It is used also for any folding of transparent capsule by which visual acuteness is lowered, and for occlusion of pupil and coloboma, the result of iritis or irido-cyclitis after the operation. Early after-cataract may be largely or entirely of temporary nature, consisting of lens matter, blood-clot or lymph. On the other hand, progressive capsular degeneration may cause a slow reduction of vision in the course of years.

Vision may be lowered by the following conditions, singly or combined:

1. Capsular abnormalities.

(*a*) Thickenings, proliferations of lens cells, dating from before operation. A large, dense anterior plaque of an overripe, shrunken cataract may have been left behind for some reason. Or there may be a much thinner posterior central patch or ring of capsular opacity. More common is the opaque capsule of a Morgagnian cataract—either simple diffuse cloudiness affecting chiefly or entirely the anterior capsule, or the same with dense white points added. The edges of the opening already made in such an inelastic capsule may lie almost in apposition, in which case the visual defect may be attributable more to the want of elasticity than to the opacity. Besides these

more obvious opacities one notices, on careful examination at the time of discharge of the patient from hospital, that the anterior capsule seldom appears altogether transparent. It is faintly cloudy, and the margins of the opening in it, more or less curled up, are frequently visible as fine grey lines.*

To what extent proliferation of lens cells† after operation is accountable for central opacities found later is uncertain. Certainly in some cases there is no such pro-

FIG. 81.

FIG. 82.

LATE AFTER-CATARACT, PURELY CAPSULAR, AS SEEN WITH CORNEAL LOUPE THROUGH THE DILATED PUPIL.

liferation. It appears more likely to occur peripherally in pockets shut off from the anterior chamber by union of the two layers of capsule.

(*b*) As early as six months after operation, but much more after several years, changes may be found especially in the anterior capsule (see Figs. 81 and 82) which have developed since the cataract extraction and which are different from anything found shortly after operation.‡ The membrane may appear almost or quite clear on examination by focal illumination, but direct ophthalmo-

* At this early period it may be difficult to decide whether some faint grey patches belong to the posterior capsule or represent cortex left behind. It is also sometimes impossible, even with the pupil dilated, to distinguish the opening in the anterior capsule. It is possible that in such cases, no capsule having been removed, but the opening in it having been large, the anterior capsule may have completely retracted behind the iris.

† See Wagenmann, *A. f. O.*, xxxv, 173.

‡ I think that once I found a mere trace of these changes quite early after cataract operation.

scopic examination with a+20 lens reveals fine opaque (black) lines, sharply defined. They are mostly disposed in the form of circles, varying in size, but all minute. But there are also, usually, other irregularly disposed lines. From their appearance one would judge that these changes indicate degeneration of the elastic capsule itself rather than abnormalities of the cells lining it. I have not seen the exact condition described elsewhere.

(*c*) Fine parallel or radiating folds in the capsule may sometimes be seen within a fortnight after extraction, but are more common later. They are more noticeable by focal illumination than with the ophthalmoscope. They are often caused obviously by the traction of organizing deposits of blood or lymph, and they are usually situated so as to influence central vision more or less. An uncommon and ill-marked form of unevenness is a waviness of the loose anterior portion of capsule, after operation on a Morgagnian cataract.

2. Cortex left behind.

If one systematically operates upon rather unripe cataracts, one must at times leave a layer of lens substance occupying the whole area of pupil and coloboma, scarcely visible, perhaps, at the time of operation, but opaque and swollen after twenty-four hours. Or trouble from hæmorrhage into the anterior chamber, or from escape of vitreous, may interfere with the removal of ripe cortex. But ordinarily, only thin layers of one or more sectors of soft flocculent material are left, projecting into the pupil from the periphery. For the rapid disappearance of lens débris the free access of aqueous humour is necessary. Therefore, slow absorption is to be expected of lens matter which is embedded in vitreous, or which becomes enclosed in a pocket by union of the two layers of capsule. This point is insisted upon by the advocates of the use of capsule forceps. Cortex which is exceptionally slow of absorption is the cream-coloured, firm, equatorial ring

of the overripe discoid cataract; but this is almost never left behind except when there is vitreous accident.

3. A fortnight or so after the cataract operation any remains of blood-clot still present are usually seen as grey bands or patches with red centres. Both these and any pigmented lymph deposits present may be found exclusively or mainly along the edges of the capsular opening. Almost invariably present with them, though not necessarily directly continuous with them, are one or more posterior synechiæ. One confidently expects by far the greater part of this early material to become absorbed, and one is often surprised at the small effect which it has upon visual acuteness. But the fine bands or thin membrane which may ultimately result from these deposits are often somewhat centrally situated, and they are apt by contraction to produce considerable wrinkling of neighbouring capsule.

From the scantiest deposits and those consisting almost entirely of blood-remains, and recognized as non-inflammatory,* it is but a step to others mainly lymphoid, and found in eyes with somewhat prolonged and intense ciliary injection, but possibly without the slightest pain or other symptom of iritis. And from such cases with very fair central vision, only slightly "complicated," it is but another step to complete occlusion of pupil and coloboma from iritis, reducing sight to moving bodies only. Many of these cases advance later a further stage to almost pin-point contraction of pupil and coloboma, with drawing up to the line of the wound. Together with this an atrophic and discoloured iris indicates total posterior synechia, and the existence of a fairly thick layer of tissue binding together the capsule and remains of iris. And some opacity of vitreous is probable, especially if the tension is at all reduced.

* See Bates, *New York Med. Jour.*, July 7, 1900.

Treatment.

Where vision is obscured by a large quantity of *cortex* in the pupil there is, as a rule, no alternative but to wait for its absorption, hastening this, if possible, by various means. Whether absorption is hastened by the administration of drugs is somewhat doubtful. Blue pill and other preparations of mercury have had a certain repute, given for this purpose. Possibly any benefit derived from them in this respect may have been indirect, through the control of iritis. The use of dionin locally has been recommended, also subconjunctival salt injections.*

Especially in eyes where the deep wound gapes a little under a large conjunctival flap, one may feel tempted to peel back the conjunctiva at some point ten days or more after operation, and to express some of the now fully ripened lens matter. I have elevated the conjunctival flap sufficiently with forceps to insert a Graefe's knife through the healing wound for this purpose as late as twenty-two days after the cataract extraction. One would not care to do this if there were still any considerable injection of the eye, or if there were any noticeable conjunctival secretion. And even so, one would scarcely care to wash out the cortex with the douche at this early period. But with proper precautions simple expression through a small subconjunctival opening appears to be free from objection.

Especially in hospital work and where one cannot be sure of keeping the patient under prolonged observation, scanty cortex in the pupillary area, with or without blood remains and lymph deposit, may impel one to early discission of the after-cataract (see below). One realizes that most of the opacity is of a purely temporary nature. But

* G. Hirsch, *A. f. O.*, xlii (1900).

one has the impression that mild irritation excited by the lens substance may predispose to organization, rather than to absorption, of fibrinous deposit, and may tend also to stimulate the lens cells lining the anterior capsule to proliferate.

The treatment of after-cataract other than cortical remains is *operative*. There have been numerous small modifications in technique and in instruments, but the outlines of treatment are defined.

The large majority of after-cataracts can be sufficiently displaced by simple 'needling' or division with a narrow knife or knife-needle. Others, more resistant, may be torn between two needles or cut by scissors. Dense capsular opacities of overripe cataracts may have to be extracted.

The proportion of after-cataracts for which needling is unsuitable varies greatly in the practice of different surgeons and in different hospitals. In Bombay this proportion has been extremely small. It depends (1) on the amount of iritis and irido-cyclitis complicating the extraction operations; (2) on the number of overripe shrunken and Morgagnian cataracts met with, and removed without their capsules; and (3) on the date upon which the supplementary treatment is generally undertaken. Tough and inelastic capsules, demanding tearing between two needles or division with scissors, are much less common shortly after the primary operation than months or years later. And there are few capsules already opaque before the cataract extraction which cannot be removed advantageously with the cataract. It is well before entering into the details of the treatment to grasp the principles which govern the application of the various measures. It is necessary to weigh the risks run against the benefits hoped for. One must inquire why in some hands even the simplest of these supplementary operations gained the

repute of being more dangerous than the primary extraction operation. And one must note the precautions which have sufficed to remove practically all risk from simple capsulotomy at least (see Kuhnt's results, p. 350, and my own, p. 346). Disaster is remarkable and disappointing in so trivial an operation. The accidents which led some surgeons to give up the treatment of after-cataract almost entirely were mainly infective, and included both panophthalmitis and destructive irido-cyclitis. There has been some trouble also from secondary glaucoma, and detachment of the retina has been known to follow.

Infection.—Devereux Marshall* reported in a list of 512 secondary operations 1·02 per cent. suppurations and 5·58 per cent. slow inflammatory changes, which ultimately diminished or destroyed sight. Trousseau† reported among nineteen discissions one panophthalmitis, four cases of iritis, one of cyclitis, and one irido-choroiditis; among ten extractions of capsule two cases of iritis and two of irido-choroiditis. During the period and at the same hospital in which these secondary operations were performed, he extracted 453 cataracts with no suppurations and only twelve cases of iritis.

It is recognized that infective inflammations have been mainly attributable to micro-organisms which have gained entrance through punctures and incisions kept open by vitreous lying in them. After discission of a membranous cataract through a corneal puncture, under certain conditions the needle on withdrawal brings with it a fine thread of vitreous, a few millimetres long, which remains hanging from the wound possibly for some days. Haab, in 1890, pointed out the nature and the danger of this occurrence. And even where no hanging thread is visible, it is

* *R. L. O. H. Reports*, xiv (1894), 56.
† *Ann. d'Ocul.*, cvii (1892), 338.

possible that vitreous, especially if abnormally fluid, may find its way into the puncture unless the latter close promptly on withdrawal of the instrument. Thus the channel for infection from the conjunctival surface is opened. The gradual backward spread of opacity has been seen in a band of vitreous thus entangled. That this has been the main source of disaster in the treatment of after-cataract is certain, for it is the combination of corneal puncture with vitreous incision that has proved dangerous. The mere corneal puncture, as shown in discission of the complete lens, is harmless in this respect. And the same appears to be true of vitreous incision, provided the humour is effectively shut off from connexion with the surface of the globe. This has been shown fairly well in the posterior scleral discission of da Gama Pinto and others, in equatorial puncture for glaucoma, and so on. In a discission through the anterior chamber a puncture immediately behind the limbus may be so readily furnished with a covering by sliding the movable ocular conjunctiva, that it seems foolish to neglect this very obvious precaution. Our Bombay work and Kuhnt's larger experience testify very strongly to the efficacy of a conjunctival covering in preventing infection. We could afford to ignore the threads of vitreous which were occasionally seen on withdrawal of the knife. Even without sliding the conjunctiva the insertion of the knife in this situation through vascular tissues is considered safer than through the cornea. And the peripheral site is less easily reached by vitreous at the close of a needling, than if the instrument had been inserted quite near the opening made in the capsule.

Knapp, however, whose excellent pioneer work did much to establish the treatment of after-cataract, has worked always with a corneal puncture placed at some distance from the limbus. His success is explained by the

avoidance of all unnecessary disturbance of the vitreous and by the use of a satisfactory instrument. He has insisted upon the importance of cutting instead of tearing the membrane, and with his needle-knife he has been able to do this without churning or displacement or deep penetration of the vitreous. Hence small chance of the vitreous humour coming forward to the corneal wound. Further, with a correctly proportioned needle-knife he has commonly ensured immediate closure of the corneal puncture, as shown by more or less complete retention of aqueous.

It is obvious that immediate closure of the puncture is essential if the risk of incarceration of vitreous is to be excluded. And to this end the opening should be as small as possible, and made without force. When the blade of a needle-knife has become worn down a little by repeated setting, the stem following it has to force an entrance through a puncture which is too small for it. Such an opening cannot be expected to close quickly afterwards. The same applies if the small wound be distorted by very free movement of the needle within it.

To sum up, it appears safest to place the puncture peripherally, partly in the sclerotic, and subconjunctivally. If corneal, it must be as small as possible, and must be made with a correctly proportioned sharp instrument, and must not be unnecessarily enlarged by free movement of the instrument. And, finally, the vitreous must not be disturbed more than can be helped.

Inflammatory reaction mostly of low type has been attributed also to pull upon the ciliary body during the division of a tough membrane. The awakening of old dormant mischief appears to explain at least the severer and more resistant cases, apparently of infective origin.*

* One may suppose that encysted micro-organisms are set free into the tissues by the stretching; or more probably that a few enfeebled

Naturally this cannot apply when the progress after the primary operation has been entirely uncomplicated.

Particular care is taken nowadays to cut the membrane always with the least possible display of force. For this the point and edge of the blade should be of the utmost sharpness, and many surgeons are careful to cut with sawing action, and to cut only the thinner portions of the after-cataract. Where there has been iritis or irido-cyclitis following the cataract extraction, leaving organized deposit and more or less adhesion between iris and capsule, it is not safe to interfere with the result for some little time after the complete disappearance of ciliary injection. An irritation-free interval of a few months (two to six) is laid down as essential. And at the secondary operation very many surgeons endeavour to avoid pull upon the iris and ciliary body by dividing the membrane, often together with iris, by de Wecker's or other irido-tomy scissors, introduced through a small corneal or sclero-corneal incision.

The question of *glaucoma* following upon the needling of after-cataract is considered later. It may or may not be of inflammatory origin. It is enough to mention here that the prophylaxis in this respect includes some of the precautions against infection and against the relighting of old inflammatory mischief. And one is careful to avoid all unnecessary churning up and displacement of vitreous and pull upon the ciliary body and iris. And quite early treatment does not appear to be nearly so liable to cause plus tension as later treatment, as explained below.

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micro-organisms still remaining in the tissues obtain suitable material for their growth in blood and lymph resulting from the slight traumatism, and develop fresh pathogenic activity, possibly greater than before.

Knapp says:* "Those operations have shown the greatest reaction—glaucoma and cyclitis—in which I have endeavoured to cut dense cords or membranes in the region of the extraction scar, the most vulnerable part of the aphakic eye. I have, therefore, avoided disturbing the cicatricial tissue in that region."

The only things in a needling calculated directly to cause or predispose to *detachment of retina* are displacement and breaking up of vitreous, and adhesion of vitreous to the puncture. In discission with scissors and in extraction of opaque capsule there may be also loss of vitreous. The complication is naturally to be feared chiefly in highly myopic eyes with vitreous opacities, due either to previous disease of the eye or to loss of vitreous during the cataract extraction. In highly myopic eyes, already predisposed to the accident, one hesitates in connecting the detachment always with the operative treatment.

In such eyes one is reluctant to perform the simplest capsulotomy for after-cataract. Even in the ordinary run of cases the bare possibility of this accident weighs against the needlings from behind through the vitreous, which have been practised, and against operations in which there is any risk of loss of vitreous.

Santos Fernandes† reported four retinal detachments following the tearing of after-cataract by needles. Morrison Ray‡ related a case of immediate detachment on needling. A considerable vitreous loss had complicated the extraction operation.

Discission with narrow Graefe or Knife-Needle.

General Considerations.—A correctly performed simple division of an after-cataract being now regarded as prac-

* *Archives of Ophth.*, xxvii (1898).
† *Arch. de Oftal. Hisp.-Amer.*, October, 1905.
‡ *Ann. of Ophth.*, viii (1899), 191.

tically free from risk, when should it be performed? And in which cases is it advisable or necessary? These two questions are linked together. For according to the period at which treatment is undertaken the problem of the selection of cases presents itself variously.

It may be taken as settled that the interval between extraction and needling should be as short as possible. Some surgeons prefer to wait until the eye is perfectly quiet—*i.e.*, free from injection—before interfering. This, however, is by no means necessary. A growing number of ophthalmologists are strongly of opinion that the discission should be done as soon as the primary wound is sufficiently firm to withstand the necessary manipulation. Mayweg operates on the tenth day, Snellen in about a fortnight, de Lapersonne in twelve to fifteen days in some cases, Haab after two or three weeks, Pagenstecher "as early as possible." Czermak made twelve days the minimum interval. Knapp recommends treatment within six weeks. In Bombay we needled generally at the end of ten or eleven days. In practically all of these early needlings the eyes were still more or less congested. Provided the iris appears bright and the globe is free from pain and tenderness, the presence of considerable ciliary injection and of moderately copious pigmented deposit on the lens capsule need cause no delay. They are not to be regarded as signs of iritis, which, as already stated, would necessitate a long postponement. Sometimes we had to postpone treatment because the eye was still quite soft. This was mostly in cases where too large a conjunctival flap had led to separation of the sclero-corneal wound, also after some Czermak operations. But we operated (always satisfactorily) in many eyes where the tension was at least -1, and where the knife-point in puncturing indented the globe. Another possible cause for delay in

needling is the occurrence of late prolapse of iris, or the presence of any small prolapse which for some reason was not at once excised. The treatment of the prolapse should precede that of the after-cataract, because a reversal of this procedure would introduce the risk of vitreous escape on the removal of the iris prolapse.

The great advantage to us of this very early treatment was that it could be carried out within the ordinary period of the patients' stay in hospital, or with an addition of one day only. Thus it was not allowed to reduce the number of beds available for major operations, and, much more important, it could be extended to nearly every patient needing it. It was done as a matter of routine, and the patients raised no objection. Whereas if they had been discharged and asked to return for further treatment, extremely few of them would ever have been seen again, and the large majority of them would thus by their ignorance and prejudice have been deprived of the benefit of the treatment. And the comparatively poor results which were frequently obtained formerly without the secondary needling must have tended to discourage others of their ignorant cataractous friends from seeking relief.

Apart from all this, early treatment has two important recommendations. (1) The capsule being now mostly of normal or nearly normal elasticity, the opening made in it gapes widely, and the simplest treatment is therefore effective. Whereas a year or two later loss of elasticity of the membrane might render a more complicated, and therefore less safe, procedure necessary to furnish the desired opening. (2) The membrane is now often much easier to divide. Any lymph deposits and remains of blood-clot on the capsule, which would later organize partly into tough fibrous tissue, at this early period offer no resistance.

Hence there is often much less pull upon the ciliary body (and upon the iris if there are posterior synechiæ) than there would be later.

There is possibly a third advantage in operating quite early, at least after cataract extraction with a fairly complete conjunctival flap. Even where there is no visible separation of the deep wound under the conjunctiva, there is probably considerably freer filtration through the wound than there will be later. This must reduce very considerably the possibility of plus tension being excited by the needling. This may largely account for our practically complete freedom from trouble in this respect in Bombay.

The drawbacks to operating early are very slight. Perhaps the most noticeable one is an occasional difficulty in deciding whether a given case requires treatment or not—whether the benefit, present or future, is likely to be sufficient to repay the trouble. Some surgeons adopt a standard of visual acuteness, and operate, as a rule, only when the result from the extraction is below the standard. But this can apply only to later needlings. A fortnight or less after operation it may be difficult, in spite of ophthalmoscopic examination of fundus and of membrane, to determine at all accurately the sources of any defective visual acuteness. We noticed this particularly after intracapsular extractions where little or nothing could be found to account for defective vision. The requirements of the individual vary so greatly with occupation, temperament, etc., that no fixed standard can obtain very general application. And the condition of the fellow eye has some bearing upon the question. Very good vision in it renders interference for the slighter grades of opacity superfluous. Or, if there be ripe or nearly ripe cataract in it, one may prefer to await the result of the second cataract extraction, before deciding whether any treatment for after-cataract

would be advantageous or advisable. If by any chance this second cataract extraction were unsuccessful, the question of subjecting the one useful eye to any risk would, of course, become a much more serious one.

In early treatment one is forestalling future requirements. Much of the opacity now present will disappear, and it is a question to what extent later capsular degeneration and folding are likely to interfere with vision. Some operators brush the difficulty aside by needling all capsules except where the patient declines the operation, or where the visual improvement is likely to be inappreciable owing to corneal opacity or fundus changes, or where the treatment is contra-indicated by high myopia or vitreous opacities, or where the conditions present counsel delay and perhaps more complicated procedure. If it be admitted that simple capsulotomy is invariably harmless, there can be no very serious objection to extending its application a little unnecessarily. But it is more scientific to take steps to learn to recognize the eyes which would never require, or derive the slightest benefit from, interference. A systematic examination of old capsules years after cataract extraction reveals in many cases the posterior capsule still absolutely transparent and unwrinkled. In such an eye it is obvious that the provision of a sufficiently wide opening in the anterior capsule, at the time of the cataract extraction, has met the whole needs of the case. My own somewhat limited observation has led me to associate these permanently clear posterior capsules most confidently with cataracts operated upon while still somewhat unripe or barely ripe. In Bombay slightly less than a third of our cataract extractions were supplemented by early needlings, but the proportion would have been higher if we had always had time to spare for the performance of the needlings.

Capsular treatment is required much less frequently after cataract extraction in which anterior capsule has been removed with forceps than when it has been simply divided with the cystitome. Very many of our needlings were for anterior capsule in which the opening for some reason was narrow or eccentric (Figs. 63-67). Treacher Collins, by removing anterior capsule with the lens, reduced the number of his supplementary capsule operations to 4 per cent. One must here recall the fact that in some eyes, as already mentioned, the treatment of after-cataract appears too dangerous to be undertaken. Another small drawback to early needling is that occasionally it causes a little hæmorrhage into the anterior chamber. One may feel doubtful whether the blood comes from the

FIG. 83.—VERY NARROW GRAEFE'S KNIFE, SUITABLE FOR DISCISSION.

congested sclerotic or from the stretched (or torn) iris. And at this early period the pull upon iris and ciliary body, in scarcely recognizable minimal grades of inflammation, is apt to increase the number of small inflammatory reactions, as compared with those one would meet with in later treatment.

The operator has still to select his instrument. The choice lies primarily between two types, the one represented by a very narrow Graefe's knife, about $\frac{4}{5}$ millimetre in breadth, the other by Knapp's knife-needle. The long Graefe blade, of which only a portion enters the anterior chamber, is intended to be used with cutting edge directed backwards only, towards capsule and iris. The short blade of the knife-needle is introduced completely within the chamber. Its round stem exactly fills the corneal or

sclero-corneal puncture made by the blade, and permits of free rotation of the blade within the chamber without leakage of aqueous. The Graefe's knife is used mostly for making a single long cut in the after-cataract. It may be readily swung around in the sclero-corneal puncture to make a second incision at an angle to the first one. The two cuts necessarily converge towards the puncture, and the angle between them cannot be large, but it is sufficient for all needs. The knife-needle, on the other hand, allows of a crucial or T-shaped incision, since a section may be made with the blade on the flat at right angles to that made with the cutting-edge backwards. A much more important difference lies in the fact that the long-bladed instrument is suited for cutting by free sawing

FIG. 84.—KNIFE-NEEDLE.

movements, whereas the short blade is adapted for dividing the somewhat mobile elastic membrane only by a sweeping cut, or by very restricted sawing movements. The blade of Knapp's medium-sized instrument, which he recommends for most after-cataracts, is $4\frac{1}{2}$ millimetres long, but only about half of the blade has a sharp cutting edge. The portion nearest the stem does not admit of being sharpened. Consequently any but the most restricted to-and-fro movement is apt to bring the blunt portion of the edge into action, tearing rather than cutting, and pulling upon the membrane and its attachments. And we have doubted whether the Knapp's needles, even when quite new from a well-known London maker, were quite so sharp as our old Graefe's knives. (We have used very old cataract knives, ground down to a suit-

able width, and tapering gradually. These blades are thin, and easily sharpened.) Either on this account or because of the difference in mode of cutting, we undoubtedly had more reactions after operating with the cutting needle than with the straight knife. The latter, with free sawing action, undoubtedly furnished satisfactory capsular openings with a minimum of pressure. One is apt, however, unconsciously to enlarge the (sclero-corneal) puncture while dividing the capsule with the long blade. In theory it should be easy to avoid this by keeping the back of the blade pressed against the tissues in the puncture. But in practice, with one's attention given up to the capsular division, this precaution is not always taken. In Bombay this enlargement of the sclero-corneal puncture during sawing occurred not infrequently. On this account, and because of a liability to pass the long blade deeply into the vitreous unwittingly while sawing, some operators have quite unnecessarily discarded the long-bladed instrument after giving it a trial. A subconjunctival puncture appears to be quite an adequate guarantee against evil consequences from vitreous exposure. The knife may enter deeply because there is nothing in the shape of the blade, at some little distance from its point, to show the depth of penetration. I have never had personal acquaintance with any harmful result of this deep penetration. The vitreous is simply incised, and not ploughed up, by the knife.

For general use in hospital practice, especially far away in India, a point against the Knapp's needle is its limited period of usefulness, owing to the disproportion between blade and stem brought about by repeated resetting, already alluded to.

The long Graefe's blade may be used to divide matted tissues—iris, organizing exudation, and capsule—where the pupil is occluded after iritis and irido-cyclitis. It may

also be expected to cut some tough capsules which seem likely to prove too resistant for Knapp's needle.

The *lighting* is of some importance, ordinary daylight being insufficient to enable one to see the membrane clearly unless it be unusually opaque. A small electric hand lamp is commonly made use of, or, when this is not available, some arrangement for focussing the light from a gas or oil lamp. An acetylene lamp has been used by Koster and van Geuns.* Focal illumination in a dark room affords the clearest view of the after-cataract, and some surgeons operate always in a dark room. In Bombay we found that bright daylight was sufficient for the performance of the needling after examination of the conditions present and of the procedure required, carried out in the dark room with dilated pupil. Ed. Jackson uses also a binocular magnifier, with a working distance of 6 inches.

A. Discission with the narrow Graefe's Knife.

The line of the incision being determined within broad limits by the position at which the narrow knife is entered, it is convenient to puncture at the outer or lower and outer† margin of the cornea. One is thus enabled to operate with the lids separated merely by the assistant's fingers. It is well, as a rule, to avoid the use of a speculum for early needlings. For (1) the union of the wound is not yet very firm, and is therefore not suited to withstand much strain, such as might be brought to bear by forcible contraction of the lids upon the speculum. And (2) the Meibomian glands at this period are commonly filled with

* *Med. Tijdsch. v. Geneeskunde*, No. 12, 1904.

† In early needling the puncture cannot be much above the horizontal corneal meridian, owing to the proximity of the healing wound.

secretion, evidently owing to the prolonged period of inactivity of the eyelids under the bandage. The pressure of the arms of the speculum therefore forces out a good deal of Meibomian secretion, and this is carried over the surface of the globe by any irrigating fluid used, unless the glands are well emptied beforehand by squeezing. And one has to be careful in the manipulation of the lids required for emptying the glands, not to allow one's fingers to slip, so as possibly to press upon the globe. Thus in early needlings the speculum is seldom used except where

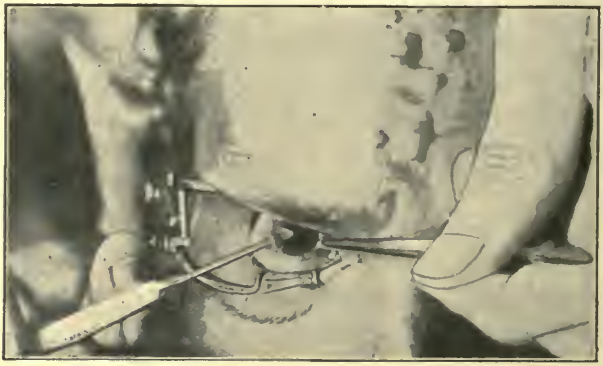

FIG. 85.—DISCISSION OF AFTER-CATARACT WITH THE NARROW GRAEFE'S KNIFE.

a vertical or nearly vertical section of the membrane is thought advisable.* It is necessary in this case, because with finger depression of the lower lid the assistant's finger would interfere with the correct placing of the knife. (The use of McGillivray's lid depressor might perhaps get over this difficulty.) For a vertical section it is necessary that the patient shall rotate the eye well upwards, and we found our patients often rather stupid over this—much

* In Fig. 85 the speculum is shown in use for an almost horizontal division of after-cataract, but this is merely for the purpose of the photograph.

more so than at the time of the major operation. All this applies only to early discission while the wound is weak, the lid margins unclean, and the patient nervous.

The conjunctival sac is washed out with perchloride before the cocain instillation, as for an extraction operation. Care is taken in this also not to press upon the eye and not to evert the upper lid, if the extraction has only recently been performed. (Mucus resulting from the perchloride irrigation may, if desired, be removed with a curette.) The pupil has been already dilated for the dark-room examination, if not still dilated from the after-treatment of the cataract extraction.

In performing early discissions, if ciliary injection be still present, the anæsthesia produced by cocain alone is sometimes insufficient. Pain is felt chiefly when the ciliary attachments are pulled upon in cutting the capsule, and it may be so marked as to prevent the making of a long incision. Therefore it is a sound rule in early needlings always to use some adrenalin preparation before or with the cocain, for the more complete anæsthesia which is obtainable with blanching of the eye. Should adrenalin not have been instilled, and should the patient show signs of feeling the insertion of the speculum or the seizure of the conjunctiva by the fixation forceps, it will be well to desist for five or ten minutes, to obtain the help of adrenalin.

The globe being fixed with forceps at the nasal side, the point of the knife is engaged in the loose ocular conjunctiva at a distance of about 2 millimetres from the site of the intended puncture—downward and outward from the common outer puncture. (In some of our old Indian patients the conjunctiva close to the cornea about its horizontal meridian—the most exposed part of the conjunctiva—is fixed by old fibrous changes, rendering the horizontal meridian an unsuitable site for puncture.) The

conjunctiva is then pushed up in a fold to the corneal margin, and the point of the knife, directed towards the centre of the pupil, pushed through the sclerotic ½ to 1 millimetre from the corneal boundary, to enter the anterior chamber. In making this puncture the back of the blade is forwards, towards the operator, and not downwards, as shown in the figure.

The point of the knife is passed inwards or upwards and inwards across the centre of the pupil to the far side of the dilated pupil or coloboma, and there thrust through the capsule by depressing the point slightly and continuing its onward movement a little behind the iris. The movement of the blade is then reversed. A single withdrawal movement may suffice to make a long incision through a thin

FIG. 86.—BRANCHED CAPSULAR INCISION MADE WITH THE NARROW GRAEFE'S KNIFE.

capsule, and the margins of the slit may be seen to separate widely, providing a broad perfectly black central space. Much more commonly some to-and-fro sawing movement of the knife is required to divide the whole or greater part of the extent of the visible membrane. The instrument should be held lightly, to avoid all unnecessary pressure upon the membrane, and the blade must not be allowed to penetrate more deeply than necessary into the vitreous. But the handle of the instrument may have to be raised a little for sawing close to the near side of the pupil, lest in the sawing movements the sclerotic be also incised.

The long slit in the capsule usually opens widely. The blade is withdrawn, and the small operation is at an end. If the puncture has not been unintentionally enlarged, and

if the vitreous has not been entered too deeply, there should be no considerable leakage of aqueous and no appearance of vitreous in the puncture.

In a few early needlings where the opacity represents the old capsular thickening of an overripe cataract, and in a still larger proportion of later needlings, where degeneration of the capsule has reduced its elasticity, or where the capsule is more or less covered by fibroid tissue, the edges of even a long opening do not separate widely. It is usually a simple matter then to swing the point around without withdrawing the blade, and to push it onwards again to puncture the membrane afresh at a spot 2 millimetres or more from the opening already made, and so to make a short branch incision to join the original one.

This, in my experience, may be relied upon to provide a sufficiently wide opening. The tongue of capsule between the two cuts retracts or becomes displaced. A few times, when dissatisfied with a transverse opening, I have immediately punctured afresh below the cornea,* and added a vertical incision to make the whole T-shaped. One is tempted often, instead of puncturing afresh, to attempt to widen a rather narrow slit in a thin membrane by sweeping the blade around in it. One is tempted especially to push aside a sheet of quite inelastic membrane, in order that the advance of vitreous into the gap may keep it open. Though often effective, at least for the time being, it is scarcely correct procedure to do anything calculated to displace vitreous. But even the second puncture of the membrane, whether made by swinging the point around or through a fresh sclero-corneal insertion, is not free from objection on this account. The backward displacement of the membrane produced by the point of the knife in

* This second incision might, of course, have been deferred for some days if for any reason this had been thought advisable.

puncturing afresh, with the cutting edge directed backwards, must force some vitreous through the slit already made into the anterior chamber.*

Provided a wide opening is secured, the meridian in which it is made usually matters nothing. The width of the gap depends very largely upon its length. If only a rather short single cut were to be made, it would have to be vertical or inclined downward and inward. The location and direction of the incisions are by many surgeons arranged to avoid tough bands of tissue, but this applies rather to old after-cataracts than to recent ones, and to the use of Knapp's knife-needle rather than to the use of the narrow Graefe's knife. In operating with the latter, deposits of fibrin, and even old fibrous bands, can be sawn through safely and readily, and their tendency to later retraction may be relied upon to widen the gap. The line of the incision may, therefore, at times be arranged to cross any dense band at right angles. Where the projecting angles of the iris at the coloboma are adherent to the capsule one often prefers to cut between them, to utilize their lateral pull (under atropin) upon the edges of the slit. Hence, one not infrequently has to cut vertically, inserting the knife (subconjunctivally) below the cornea,† and passing its point well up in the coloboma. Rarely some displacement of the line of section may be necessary on account of corneal leucoma.

Occasionally, in eyes fit for early needling the anterior chamber is still rather shallow. There appears to be still

* There is not the same objection to a second perforation of the membrane with the flat of the blade parallel to the iris, as is done with Knapp's needle. Therefore the latter instrument is preferable for double cuts; some increase of the pull upon the ciliary body, by loss of the sawing action, being probably less to be feared than displacement of vitreous.

† Fixation forceps applied at the inner side of the cornea, as for the transverse cuts.

some leakage through the healing wound, but not so much as to make the globe too soft for operation. Some care is needed to direct the point of the knife slowly through sclerotic and cornea into the angle of the chamber. The puncture is easier in these eyes with a Knapp's needle, as the blade can be inserted on the flat. These have been the only eyes in which I have ever felt that there was any real (though very small) advantage in using an instrument which could be rotated on its axis.

Many of our patients were sent out of hospital with the eye bandaged up for a day. For patients kept in hospital the wire shade should suffice.

Complications.

A. *At the time.*—1. I failed to divide one extraordinarily elastic membrane.

The tissue was scarcely at all opaque, but a good deal folded. And since the attempt at division produced a reaction lasting several days, I did not try again.

I refrained altogether from interference with another peculiar capsule, fearing the same trouble, or possibly detachment of retina in case the discission were accomplished. It was in a girl, after linear extraction. The lens had been transparent, but operation had been undertaken for myopia and for a small, dense posterior polar opacity. This opaque patch was left in the centre of a distinctly tremulous transparent posterior capsule.

2. Rarely a tough membrane may tear near its inner, or upper and inner, attachment when the pressure of the knife is placed upon it to perforate it. This may be partly due to a slightly blunt knife, or to the application of too much backward pressure with too little onward movement of the blade. Otherwise it indicates that the case would have been better dealt with by the double needle operation, or more complicated procedure. The

large central leaf may often be considerably displaced outwards and downwards by the knife, at the cost of only moderate disturbance of vitreous; but usually it springs back sufficiently to cover the centre of the pupil. It is not sound practice to make repeated attempts to depress the membrane in the vitreous. Should the vision obtained through the irregular and eccentric opening be insufficient, the offending membrane may be extracted later or divided by scissors, though with almost certain loss of some vitreous.

3. In a small percentage of cases slight hæmorrhage occurs. Next day a little blood may be found at the bottom of the anterior chamber, with some turpidity of aqueous. The reduction in vision thus produced is very transient. This complication occurred in one of our discissions which was not at all 'early.'

B. *Later.*—1. Very occasionally either a repetition of the same operation at a different angle, or a tearing apart with two needles, may be needed for an inelastic capsule, the slit in it having failed to remain sufficiently open. This is especially likely to happen where the cataract has been Morgagnian.

2. Inflammatory reaction should be rare, and should yield quickly to treatment.

The only acute reaction noted in Bombay of late years was in a case where the cataract was of traumatic origin, and where some iritis had followed the original injury. The reaction subsided in ten days, with satisfactory improvement in vision.

In another patient early discission was followed by chronic nodular iritis, lasting a few months. It was probably excited more by the extraction operation than by the needling. The eye had been inflamed several years before. And the recrudescence of apparently tubercular mischief after so long an interval was somewhat interesting. There was no evidence of

tubercle elsewhere. The nodules, three in number, which formed in the lower part of the iris subsided, together with the iritis, leaving the capsular opening sufficiently wide and clear for very fair vision.

Apart from these cases only a few trifling reactions have occurred in our practice, passing off in a few days under treatment by atropin drops, with perhaps warm fomentations.

By the subconjunctival puncture we have been secure against fresh infections, such as might lead to suppuration. Once, years ago, I had a panophthalmitis after puncturing through the cornea. Vitreous had entered the small wound. Da Gama Pinto, puncturing through the cornea with a narrow Graefe's knife, reported nine incarcerations of vitreous in 198 discissions. In four of these eyes suppuration occurred, and two of the eyes were lost.

In eyes affected by chronic uveitis, whether in any way dependent upon the secondary operation or not, the capsular opening may gradually become occluded by inflammatory deposit. Some rare instances of membrane formation in the capsular opening have been seen in eyes quite free from irritation (some of them highly myopic).*

3. I can certify that after nearly all of our operations for after-cataract in Bombay of late years, and certainly in all where there was the slightest suspicion of trouble, the tension of the eye was tested. It was only once found a little elevated, and this rise disappeared in a few days without treatment. We performed 251 early needlings, in addition to 33 late needlings within the last fifteen months of my work in Bombay.

McGillivray,† impressed with the importance of cutting by sawing movements, has designed a curved knife-needle with

* A. von Hippel, *A. f. O.*, xlix, 2, 387.
† *Trans. Oph. Soc.*, xxvii (1907), 108.

long convex cutting edge and with cylindrical stem. The incision in the membrane is made entirely with the convex edge. He prefers an oblique incision from above, downwards and a little inwards.

Schnabel * used either a narrow Graefe's knife, or a similar blade, sharpened at both edges for 8 millimetres from its point. The introduction and the cutting were done with the flat of the blade parallel to the iris.

B. Operation with Knapp's Knife-Needle.

Knapp prefers the knife-needle, "because needles cutting on both sides can for equal sizes not be made so sharp."† The straight instrument is preferred because "curved needles are difficult to introduce through the cornea, and still more so through the capsule. . . . The straight point transfixes the membrane with greater ease, less pressure, and therefore less tearing at the ciliary processes." If there are no special indications he inserts the needle, with cutting edge backwards, in the horizontal meridian of the cornea 3 millimetres from its margin. A horizontal incision 4 or 5 millimetres long is made in the capsule. And then with the needle rotated to present the cutting edge downwards the membrane is transfixed above, and a short vertical cut is made downwards to join the horizontal incision. The addition of a similar short vertical cut below provides a crucial opening. The first cut is made by a simple withdrawal movement of the instrument, the secondary ones by sweeping action. The incisions have to go through the softest parts of the capsule; hard and inelastic bands and patches should not be attacked. "Two incisions may suffice, in the shape of a T, or the one crossing the other at an acute angle."

* Elschnig, *Wiener Kl. Wschr.*, ix (1896), No. 53.
† Norris and Oliver's 'System,' iii, 812.

It may well be that the central crucial or T-shaped opening with Knapp's needle is particularly suited to his work. The untouched central capsule, after simple extraction with 'peripheric splitting' of the capsule, must give fairly uniform and accurate results from comparatively short incisions. On the other hand, the central and paracentral adventitious bands, lying along the margins of the ordinary central capsular opening, as in our work, suggest the need for freer division. Knapp tabulated the vision of seventy eyes before and after needling. The amount of vision was more than doubled by the operation. It averaged slightly less than one-fifth before, two-fifths after treatment.

Should a corneal puncture be used, after Knapp, and should vitreous enter it, any hanging thread would be cut off. Similar threads unconnected with vitreous, and representing filamentary keratitis, have been mentioned in connexion with discission punctures (see Haab, 'Operative Ophthalmology,' p. 168).

Ed. Jackson,* using Knapp's knife-needle, makes two incisions, meeting one another in the form of a V, each made by sweeping movement. The blade is inserted on the flat and kept so—*i.e.*, with cutting edge downwards, not backwards. The puncture is at the limbus, down and out. The nearer limb of the V is cut first. Stress is laid upon the mechanical advantage of the peripheral insertion in the longer leverage obtained. "The same length of sweep of the knife edge will be obtained with one-half of the twisting of the shank in the puncture—less than one-half of damage to adjoining tissues." The short sweep obtainable through Knapp's corneal puncture may accomplish almost nothing, owing to elasticity of the capsule, and owing at times to the near approach of the capsule to the cornea through leakage of aqueous beside the needle. This leakage may occur with a perfectly proportioned instrument, owing to the pressure exerted upon the rigid corneal tissue in the swinging movements of the needle. With the peripheral

* *Arch. of Ophth.*, xxxv (1906), 127.

insertion there may be some slight difficulty in accurately locating the capsule puncture, but the difficulty is too trifling to be of practical importance.

Czermak* used Knapp's needle, inserted at the limbus, to make usually a single long incision by sawing action. The opening was made T-shaped in inelastic capsules.

Kuhnt † uses Knapp's needles with stems bent to admit of their (subconjunctival) insertion at any selected point of the limbus. He also is satisfied with a single incision 7 to 8 millimetres long in thin capsules. For a T-shaped opening he uses two needles, inserted rather close together, with cutting-edges in opposite directions. The second portion of the incision is made by the two edges approximated to cut with scissor action. Where there are posterior synechiæ, the two cutting needles are made to penetrate the membrane together centrally, and cut in opposite directions towards the periphery. Special forms of incision are designed also for cases in which there has been loss of vitreous, and where the capsule has healed in the wound. In an experience of about six hundred discissions there were no losses, and the vision improved in nearly every case. In the last hundred cases there was a improvement in visual acuity from 23·8 to 58·7.

De Lapersonne and Poulard ‡ have divided secondary membranes from behind by a sickle-shaped needle introduced above, 1 to 2 millimetres above the summit of the flap made in the extraction operation. They operated from the eighth to the fifteenth day after the extraction.

Posterior scleral discission was practised largely by the old Vienna school, and later by Da Gama Pinto.§ A cutting needle or narrow knife was inserted in the region of the ora serrata, 6 to 8 millimetres behind the limbus, and passed forward through the vitreous to transfix the capsule at the near side. The point of the instrument was then pushed on parallel to the membrane, and again passed through the capsule from in front at the far side of the pupil, and the division completed by sawing movements. In the light of

* *Die Augen. Op.*, S. 864.
† *Zeitsch. f. A.*, i (1899), 151 and 260.
‡ Tenth International Congress, Lucerne, 1904.
§ *Ann. d'Ocul.*, cxvii (1897), 22.

what has been said above upon unnecessary disturbance of the vitreous, further detailed description of the procedure and discussion of the suggested dangers appears superfluous—risk of hæmorrhage into the vitreous, dislocation of the capsule into the vitreous, danger of detachment of retina from healing of vitreous in the puncture. Pinto in 133 operations improved the vision in ninety-five, and reduced it in seven cases. In three cases glaucoma followed. Noyes* considers that this treatment should be adopted one to three months after the original operation, where a small and undilatable pupil (whether simply rigid or bound down by synechiæ) does not provide sufficient room for ordinary discission of the capsule through the pupil. In such cases, however, no particular harm follows limited incision of the iris.

Opinions upon the treatment of the thicker, denser, and inelastic forms of after-cataract, including those resulting from iritis and irido-cyclitis, vary greatly. All of these after-cataracts are divisible primarily into those which can, and those which cannot be cut with a narrow Graefe's knife. The latter membranes may be torn, or divided with scissors, or extracted. The former group includes the results of iritis and irido-cyclitis after cataract extraction, even to complete occlusion of pupil and coloboma, and matting together of iris and capsule by organized exudation.

I have been in the habit of practising simple division of such membranes with the narrow knife, cutting the iris freely together with the tissues behind it when necessary. This is not commonly considered sound practice, for the pull upon the ciliary body is considered to be too great. Further, on this account only one incision must be made at a time. If there be dense occlusion of pupil, the single incision in the matted tissue does not gape well. A second incision at right angles to the first may be needed

* *Medicine*, January, 1900.

to make the whole T-shaped, as soon as the eye has become perfectly 'quiet' after the first attempt. My experience with fully occluded pupils has been small. So far I have not seen any bad results from this treatment. The openings have not become closed by blood-clot or lymph, as they are said to do sometimes. I have made the primary incision vertical, because it has sometimes sufficed alone, even though narrow. But it is usually made horizontal to obtain the benefit of the vertical pull of the stretched iris. It is questionable whether the complete division with a really sharp knife entails any more pull upon the ciliary attachments than any other mode of cutting, for in order to be cut with scissors the matted tissues must be first pierced, to allow of a blade of the instrument being inserted behind the membrane. If, as is usual, this puncture be made with the keratome or scissor point, this must almost certainly need as much pressure upon the membrane as the long incision with the much sharper narrow knife. And the scissor operation has the serious drawback of very frequently allowing vitreous to enter the wound, and perhaps to escape through it. This disadvantage is not shared by the simpler operation. A fair result may be hoped for by operation after severe irido-cyclitis, provided the tension of the globe has not been much reduced, and provided the field of projection of light is good. In testing this field allowance must be made for extreme upward displacement of the pupil. One is surprised to note how light penetrates through a densely occluded pupil.

Haab* supports the iris by two Bowman's needles, and cuts between them. The needles are introduced one after the other from the temporal side through cornea and iris, parallel to each other and 3 millimetres apart. They are then held by the assistant, who also fixes the globe. The cutting

* 'Operative Ophthalmology,' p. 172.

is done with a Knapp's needle,* introduced in the horizontal meridian near the nasal margin of the cornea.

Galezowski,† in cases of after-cataract with iritic adhesions, has employed two needles with sickle-shaped blades, one nearly straight, the other more curved. The membrane is perforated twice by the point of the more curved instrument, first on the near side from before backwards, and on the far side of the pupil from behind forwards. The two needles are introduced through the cornea, and either may be used to support the membrane while the other cuts with sawing action. Thus the cutting may be done from in front by the straight needle or from behind by the curved needle.

Kugel ‡ operates upon these cases with an ordinary Graefe's knife, introduced at the outer margin of the cornea, with its edge directed down or up. The iris is supported by a bent needle passed behind the iris from the inner corneal margin. The cutting is confined as far as possible to the site of the former pupil, several small punctures being made, leaving, perhaps, only isolated threads crossing the pupillary area which may admit of extraction. For this extraction the corneal opening made with the knife is enlarged slightly to admit of the entry of forceps.

In the practice of various surgeons the remaining procedures receive a much wider application than is absolutely essential. Opinion differs chiefly with regard to after-cataracts which are inelastic and somewhat tough, but which still admit of incision with cutting needle or narrow knife. Tearing between two needles is evidently used as routine procedure for ordinary after-cataract in some places.§ And Panas practises extraction of the majority of them.

It may be stated broadly that in *tearing* the membrane the use of two instruments is necessary, the one to counteract the pull of the other, and to prevent the pull being

* Better would be a narrow Graefe's knife.

† *Rec. d'Opht.*, October, 1896, p. 587.

‡ *A. f. A.*, lxiii (1906), 3.

§ Elliot, *Ind. Med. Gazette*, xli (1906), 165.

transmitted to the ciliary body. The simplest procedure is the **Double Needle Operation.*** The two needles can be inserted subconjunctivally on either side of the cornea to penetrate the centre of the capsule at the one opening, and to tear the membrane from the centre outwards by separation of the needles in various directions. It has an obvious advantage over all operations which require definite incisions for the insertion of instruments, in being free from the risks attending possible impaction of vitreous in the wound and loss of the humour. The objection to the method lies in a tendency to ploughing up and displacement of vitreous. It is, therefore, a distinctly severer operation than simple capsulotomy. If the needles be inserted at the two ends of a corneal meridian, their points, when separated in the capsular opening, swing directly backwards into the vitreous, often carrying one or other leaf of capsule back also. Their points of insertion may be placed at some distance from a corneal meridian, so that the needles converge obliquely to the capsular puncture from above. The separation of their points then does not plunge them deeply into the vitreous. The needles remain still nearly parallel with the surfaces of iris and capsule. But the separation is apt to be less effective in tearing, in that it does not admit of being repeated in such varied directions as when the sclero-corneal punctures lie in a corneal meridian.

The method is suited to old after-cataracts, inelastic, and somewhat dense from capsular degeneration and from the development of fibrous bands and membrane, with or without posterior synechiæ. Also for many capsules of overripe cataracts, including Morgagnian and those with an anterior plaque which is not very dense, at least at its centre.

* Bowman, *Medical Times and Gazette*, October 30, 1852; and *Medic.-Chirurg. Transactions*, 1853, p. 315.

Technique.—The preliminaries are the same as for division with the narrow knife. The speculum is inserted and the operator stands behind the patient's head with a Bowman's stop-needle in each hand. The globe is fixed below by the assistant. If the membrane appears dense, the needles are inserted subconjunctivally at each end of the horizontal corneal meridian, or near it. Each needle is directed parallel with the surface of the iris toward the

FIG. 87.—BOWMAN'S STOP-NEEDLE WITH CUTTING SIDES.

middle of the dilated pupil. The one at the nasal side of the eye is inserted first, the globe being rotated outwards to allow of this. Either needle is thrust through the thinnest part of the centre of the capsule, and followed by the other at the same point, or quite close to it. Since the angle at which each needle meets the capsule from the limbus puncture is very acute, the point naturally does not penetrate the membrane so easily as if it had entered

FIG. 88.—DISCISSION WITH TWO NEEDLES.

nearer the centre of the cornea. One needle is therefore used to fix the tissue, while the opposing point is thrust through. If any difficulty is experienced in puncturing, a small central tear may be made by separating the points caught in the tissue. The points are then separated widely by bringing the handles of the instruments together in front. The width of the capsular slit thus made is tested by allowing the points to come together again. Usually they

need separating again as much as possible, at least once, in another direction to secure a wide opening. The leaves of the torn capsule are kept apart more by the forward projection of vitreous than by the tension of the membrane. But the vitreous must not be unnecessarily displaced.

Only where the membrane is fairly thin, as, for example, in many Morgagnian cataracts, may the limbus punctures be both placed above—the one up and in, the other up and out. With both needles directed to the capsule from above neither can be quite so useful in fixing the membrane to resist the thrust of the other needle as when they meet from directly opposite points. There is, therefore, some loss in efficiency in this respect, as well as in the tearing apart of the capsule, to make up for the gain in safety from the reduced disturbance of vitreous.

The displacement of vitreous in this operation must introduce a slight risk of exciting increase of tension, or possibly detachment of retina (see Santos Fernandes' experience, already mentioned). Our experience of the method in Bombay was small. A rise of tension followed in two of our cases. Curiously, both cases were in children. One was relieved by leakage of aqueous through the needle punctures on manipulation of the eye.

One must be prepared, also, rather frequently to find the margins of the opening in the inelastic membrane approximating more or less, though not, in my experience, so much as to necessitate extraction of the capsule. The method has been practised a good deal in England. Bowman punctured through the cornea well within the limbus. Streatfield used two needle-hooks. Knapp has used two of his needle-knives in place of Bowman's needles.

Stilling* has operated similarly with two harpoon-needles, introduced at the limbus. If it were desired to extract the membrane, these needles, introduced through small incisions made with a Graefe's knife, sufficed to draw out the tissue.

* *Centralbl. f. prakt. Augen.*, September, 1899, S. 261.

Pflüger* modified the needles to render them easy of withdrawal.

Some operators† have used a cystitome introduced through a small marginal puncture to cut or tear the capsule.

In Agnew's‡ operation both cornea and capsule are pierced with a broad needle near the upper margin of the cornea. This needle is retained in position while a wound is made at the lower corneal margin, and through this a small sharp hook introduced. The point of the hook is inserted into the capsular opening occupied by the broad needle, and traction put upon the hook to tear the membrane. The broad needle defends the ciliary region from the traction. As much tissue is drawn out of the wound as possible, and cut off by the assistant with scissors.

Noyes§ has described a similar operation with two hooks pulling against one another. The hooks are introduced through limbus puncture and counter-puncture, and through a central capsular opening, made with a Graefe's knife.

Discission with Scissors.—This is applied for the varying results of irido-cyclitis—*i.e.*, where the after-cataract is fairly dense and more or less attached to, or united with, the iris. The operation is a capsulotomy or irido-capsulotomy, according to the degree of occlusion of pupil and of coloboma, and in performance is almost identical with de Wecker's iridotomy.

The eye having been prepared as usual, an incision is made 5 to 6 millimetres long, with a keratome, at the limbus or a little within it. Should the cataract extraction have been combined, and should the pupil be not much displaced upwards, the incision is placed above in front of the old cicatrix to allow of vertical section of the membrane. If, however, there has been no coloboma made, as after simple extraction and when the condition results from a traumatic cataract, or if the pupil and coloboma has been drawn up‖ to the line of the old wound, the corneal incision may be made at the outer side to allow of horizontal division of the membrane. Sym's blade (Fig. 89)

* *Ophth. Klinik*, vi (1902), No. 13, S. 193.

† Prouff, *Rev. Clin. d'Ocul.*, novembre 3, 1884.

‡ Noyes, *Ophth. Hosp. Rep.*, vi (1869), p. 209. § *Loc. cit.*

‖ The vertical traction of the iris may then be expected to open the slit in the membrane.

is suitable for the section. The fixation of the globe is on the opposite side of the cornea to that selected for the incision. The knife is introduced into the chamber slowly parallel with the iris. It is then nearly withdrawn to allow aqueous to escape and the diaphragm to come forward, and the point again thrust onward to pierce the capsule and, if necessary, the iris, close to the corneal wound. The blade being then withdrawn, de Wecker's scissors are introduced. One

FIG. 89.—SYM'S KNIFE (FULL SIZE).

blade is passed in front and the other behind the membrane through the small puncture, to make a central incision, long or short according to the apparent needs of the case, as indicated by the thickness of the tissue and the size of the pupil and coloboma, and the appearance of the iris.

Should a single incision fail to gape, a second is made at an angle to outline a >-shaped section. The tongue of tissue included between the two cuts may be expected to shrink

FIG. 90.—BROAD IRIDO-CAPSULOTOMY (LINE OF INCISION IN IRIS AND CAPSULE).

slowly if it does not at once retract sufficiently. The tongue of tissue may be made broad by using a broader keratome and placing the two diverging cuts at each end of the (longer) incision made by the keratome in the diaphragm (Fig. 90) instead of from its middle.

The after-cataract may be pierced by the sharp blade of de Wecker's scissors, if preferred, or by a Graefe's knife, instead of by the keratome for the single or >-shaped section.

Schweigger* makes a smaller incision, and uses scissors

* *A. f. A.*, xxxvi (1897), S. 1.

like de Wecker's, but reduced in size to lessen the risk of vitreous escape.

The main objection to this operation—viz., the considerable risk of incarceration and loss of vitreous, has been already mentioned. The danger of infection from this cause, however, might be diminished or removed by inserting the knife subconjunctivally through sclera and cornea instead of simply through the cornea. This should increase the difficulty of the operation but slightly.

Apart from accident (infection or retinal detachment, due to vitreous prolapse), and from insufficient retraction of the membrane, and from subsequent closure of the opening by recurrent inflammatory changes, the visual result is often poor from vitreous opacities and other changes in the eye due to the previous iritis or irido-cyclitis.

Strawbridge * designed a scissor-like instrument, with fine-pointed blades, 8 millimetres long, cutting at their outer edges. The closed instrument was used to pierce the after-cataract, and the opening was enlarged by separation of the blades, as in discission with two needles. Blades cutting at both edges were also used.

Lewinsohn † later used scissors like de Wecker's, but with blades rather narrower and shorter, and cutting at their outer edges. These closed blades can be thrust through the uncut cornea like a needle. There is, however, little advantage in this—certainly no guarantee against the entrance of vitreous into the puncture.

Where the iris is atrophic, and therefore devoid of resiliency, partial **Excision** of the matted tissues—iris, capsule, and inflammatory membrane—has been held to be necessary. This, however, appears doubtful, for slow retraction of a severed flap or tongue of the diaphragm should take place. Even the projecting angles of tissue formed by a **T**-shaped division commonly retract a little, in spite of a dense substratum of new fibrous membrane. And excision operations are extremely likely to lead to considerable loss of vitreous in eyes quite unfit to bear the loss. Hence the results obtained by excision have been very uncertain.

* *Amer. Journal of Med. Science*, 1877, p. 449.

† *Centralbl. f. prakt. Augen.*, Juli, 1899, S. 207.

De Wecker designed two methods (iritoëctomie) of operating, shown in the accompanying figures. In the first method an upper corneal incision, 6 to 8 millimetres long, made with a keratome, is followed by a parallel incision through the diaphragm, after emptying the anterior chamber of aqueous. Then two cuts are made by de Wecker's scissors, as in iridocapsulotomy, but the cuts converge instead of diverging. Thus a triangular piece of membrane is isolated, and may be withdrawn by the scissors or by iris forceps. Its apex should be a little below the centre of the cornea. In making the second of these cuts, the leaf of membrane needs to be drawn tight with forceps.

FIG. 91.

FIG. 92.

DE WECKER'S IRITOËCTOMIE, TWO METHODS.

In Fig. 91, *a*, *b*, corneal and iris incision; *c*, *e*, *d*, triangular portion excised.

Second Method.—Where the pupil and coloboma are drawn up to the scar (above), and the diaphragm is thick and dense, the incision through cornea and diaphragm is made below by puncture and counter-puncture with a narrow Graefe's knife. The aqueous is allowed to leak away as soon as the corneal puncture has been made. There may be considerable difficulty experienced in dividing the tissues with the scissors.

Punches have been designed for the cutting away of portions of tough membrane. Stevenson* described an improvement upon an instrument devised by Kruger-Krjukow. Vacher has used a somewhat similar instrument.

Knapp describes an operation, *irido-cystectomy*, in which he draws out iris and pupillary membrane by means of a blunt hook, after section, to be excised by scissors.

Extraction.—There is only one form of after-cataract which appears almost to demand this treatment. It is

* *Ophthalmology*, January, 1906.

where a large dense anterior plaque has for some reason been left behind. But in Europe such capsules must be decidedly rare. And when met with they are likely to escape extraction with the cataract only under exceptional circumstances,* especially now that an impulse has been given to intracapsular extraction by Smith of Jullundur. Smaller anterior plaques admit of ready displacement sufficient to clear the pupil, and thin ones admit of being torn by two needles. Extraction of after-cataract, at one time considerably practised, has been brought somewhat into favour again of late years by Panas† and de Wecker for all capsules which are not too thin to permit of extraction, and not broadly adherent to iris (a few fine synechiæ are of no consequence). Panas finds that the consequences which might be supposed to follow—cyclitis from pull on the ciliary body, vitreous opacities, glaucoma, and detachment of the retina—do not occur even so frequently as after simple discission (!). Apart from the risk of prolapse and loss of vitreous, it is a great drawback to the treatment that it cannot follow early after the cataract extraction. An interval of three to six months must be allowed for all the reaction to have passed off and, according to Panas, for the membrane to acquire firmness. Not many patients can be induced to return for a second operation after so long an interval.

Technique.—The pupil must be dilated, and the eye prepared as usual.

An incision is made with a keratome above, 5 millimetres or more long (8 to 10 millimetres, Panas), either 1 to 1·5 millimetre

* I have had to leave them behind at the time of the cataract extraction on account of loss of control by the patient during operation, and in other cases because I did not care to risk prolapse of vitreous when the conjunctiva was unhealthy. I have not met with them in eyes with vitreous tension.

† *Arch. d'Opht.*, xxii (1902), 149.

within the limbus, or subconjunctivally just behind the limbus (the conjunctiva being pushed downwards by the knife from a point 1·5 or 2 millimetres above the cornea). The purely corneal site is to enable the operation to be performed without iridectomy if a coloboma has not already been made. The more peripheral site necessitates a coloboma, either dating from the primary operation or made at this time, to facilitate the seizure and removal of the membrane, and to guard against prolapse or incarceration of iris. But there seems little doubt

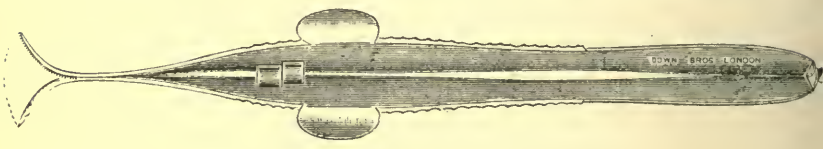

FIG. 93.—PANAS' CAPSULE FORCEPS.

it should always be chosen. One has no right to expose the eye to the risk of vitreous being left uncovered in the wound. A small iridectomy may be useful, also, to free the capsule from one or more small iritic adhesions.

Suitable capsule forceps must be selected, or an attempt may be made with a sharp lens hook. There is no difficulty in seizing a dense anterior plaque with any kind of capsule forceps. But if the whole capsule is to be extracted, an instrument with fairly numerous teeth is needed to give a firm

FIG. 94.—EXTRACTION OF CAPSULE.

hold and to guard against slipping of the forceps and against tearing of the membrane.

In dealing with more ordinary after-cataracts, Liebreich's and de Wecker's forceps, with few teeth, have been used mainly for partial extraction, the central portion being seized and often torn away as in operating for cataract extraction. Panas' forceps afford a large firm hold. One blade, pointed, is thrust through the capsule and passed down close behind it in the vitreous. The membrane is then seized between this and the other blade in front. Slow traction with slight lateral

movements is used to free the opaque capsule gradually from its zonular attachments. An impatient pull is likely to tear the membrane and to bring vitreous forward into the wound.

If a dense after-cataract resist considerable traction, it is recommended to alter the procedure to a capsulotomy with de Wecker's scissors, especially where there are posterior synechiæ, lest irido-dialysis be occasioned.

Should the capsule tear and the opening be insufficient, it is recommended to enlarge the opening by de Wecker's scissors introduced through the wound. Should the capsule be adherent to the scar of the cataract operation, it is cut away with scissors close to the wound.

Cortex imprisoned between the two layers of capsule may be set free into the anterior chamber by the manipulation of the forceps It may be removed by irrigation, if the diaphragm in front of the vitreous is still intact. Otherwise some slight attempt may be made to express it.

The sharp hook, like forceps with few teeth, is apt to tear the capsule instead of pulling it away from the zonule. The point is passed down to piece the lower part of the membrane at a comparatively thin spot. Its hold may perhaps be strengthened by twisting the instrument on its axis in an attempt to roll up the capsule. Should the capsule tear after being considerably loosened and displaced, ordinary iris forceps may serve to withdraw it; otherwise capsule forceps may be needed.

Tearing of the membrane may interfere with anything approaching complete removal of it, but repeated attempts to seize torn capsule embedded in vitreous are not advisable if a fairly central incision has been made.

Complications.—There may be prolapse or incarceration of iris if iridectomy is not done at the time or at the primary operation. Loss of vitreous is frequent. It is practically certain to take place should the operation be undertaken after an unsuccessful discission, by which the diaphragm has already been perforated, and vitreous brought forward into the anterior chamber.

DETACHMENT OF THE RETINA.

Loss of vision from this complication is feared especially after large escape of vitreous. The complication has also been attributed to healing of the vitreous in scars, whether following actual loss or not. It is then due to the formation of bands in the vitreous, connected with the scar. It has also been ascribed to the mere displacement and 'ploughing up' of vitreous in some discissions. And in highly myopic eyes it seems that some of the retinal separations which have followed removal of the lens, if due to the operation at all, must be ascribed to the uncomplicated operation, the diaphragm consisting of zonule and posterior lens capsule having been kept intact. In highly myopic eyes it appears advisable to refrain from interference with posterior capsule, at least in the present state of our knowledge with regard to the complication. The accident may happen while the patient is in hospital, or only after a considerable interval. Its early recognition may be difficult owing to after-cataract, and possibly owing to vitreous opacities. Lately I observed a case which underwent spontaneous cure.

A fortnight after a Czermak's subconjunctival extraction a prominent grey opaque retinal detachment was found downwards and outwards. The vision was fingers at 8 feet with a suitable lens. Ten days later the detachment was very shallow and folded, and the retina grey only in the ridges. $V = \frac{6}{40}$. Shortly afterwards no detachment was made out.

Complete separation of the retina is one of the consequences of protracted irido-cyclitis, but in itself is of little consequence, as vision is otherwise destroyed.

CHAPTER VI

COMPLICATED AND SOFT CATARACTS

Cataract with glaucoma—Cataract secondary to irido-cyclitis—Removal of the transparent lens in high myopia—Dislocated lenses—The extraction of soft cataract—Suction.

CATARACT WITH GLAUCOMA.

THE shallow anterior chamber commonly seen with the swollen liquefying form of cataract has been repeatedly referred to in the foregoing pages. As might be anticipated, this shallowing sometimes causes, or assists in causing, glaucoma.

In Bombay the triple association is fairly frequently seen of recent congestive glaucoma with swollen cataract and very shallow anterior chamber. And the connexion is emphasized by the following considerations: (1) These cases include, perhaps, the majority of the subacute glaucomas seen there, the great bulk of primary glaucoma in India being distinctly chronic, simple, or congestive. (2) Other forms of cataract associated with *recent* attacks of congestive glaucoma are decidedly uncommon. (3) The shallowing of the anterior chamber is frequently extreme. Where comparison can be made with the chamber of a fellow eye as yet uninfluenced by glaucoma, by cataract, or by cataract extraction, that of the glaucomatous eye is generally distinctly the shallower of the two. In a few

cases the difference in depth is inappreciable ;* but it must be borne in mind that the dilated pupil and altered iris of the affected eye prevent very exact comparison between the two eyes. This difference in anterior chambers, though not quite exclusively the property of these cataractous glaucomas, is sufficiently so to remain their chief distinctive feature. During the period of collection of the statistics given below it was found but five times in glaucomatous eyes without cataract, or with only incipient cataract. In ordinary congestive, subacute or chronic† glaucoma the relation is commonly reversed; the chamber of the affected eye is shallow, but less so than that of the unaffected, but predisposed eye. (See Czermak, quoted in the *Ophthalmic Review*, xvi [1897], 199).

It is by no means contended that the cataract formation always takes a very large place in the etiology of these high tensions. For the large majority of such swollen cataracts pass through their whole course without altering the tension of the eye at all. And of the thirty-three of these cataracts associated with recent congestive glaucoma, of which I have notes,‡ five had advanced to the Morgagnian stage, though in four out of these five cases the glaucoma was by no means advanced. In two of them there was still some pupillary reaction obtainable ; in one of these two and in another case the tension gave way completely to eserin before operation ; and in the fourth case the attacks of high tension had been intermittent.

Among other factors in etiology may be noted the predisposition to glaucoma frequently shown by the (less) shallow chamber of the unaffected fellow eye. And at times there is

* I have very rarely seen congestive glaucoma together with Morgagnian cataract and an anterior chamber *deeper* than that of the unaffected eye ; but in only one case was the glaucoma apparently of recent origin. In this case it must be assumed that the cataract played no part in the production of the high tension.

† I cannot speak from experience with regard to acute glaucoma, having had but a small acquaintance with it.

‡ Collected some years ago.

a definite exciting cause for the onset of high tension; in two of our cases it was operation upon the other eye, and in at least one other case it was probably the use of a mydriatic.

During the two and a half years over which the above thirty-three cases have been spread, six similar cataracts were seen with only a low degree of *plus* tension, in eyes quite or nearly free from injection. And ten others were found without high tension, but with some enlargement and sluggishness of pupil. In six of these cases the abnormality of pupil was very slight, and might easily have escaped notice. In two of the remaining three, there was contraction of the field of projection also, evidently from high tension that had passed off for the time.

Thus the *prima facie* presumption in favour of this etiological relationship between swollen cataract and glaucoma is supported by a considerable body of evidence. It is in our experience further borne out in *treatment*. In two of our first few cases treatment of the glaucoma was attempted on orthodox lines, but both cases gave a lot of trouble.

In one case the anterior chamber failed entirely to refill after a perfect iridectomy with conjunctival flap. *Plus* tension returning after three weeks necessitated cataract extraction, assisted by preliminary posterior scleral puncture. The incision had to be made mostly with scissors, owing to the absence of an anterior chamber. Some cortex was left obscuring vision; and three weeks later still, *plus* tension was again evident. After another posterior scleral puncture the patient disappeared, tired of treatment.

In the other case the tension was finally reduced, and useful sight restored by a 'sclerotomy with conjunctival infolding,' after the failure successively of (1) eserin with small sclerotomies, (2) iridectomy, (3) cataract extraction, and (4) sclerotomy with division of adherent root of iris.

In the light of these cases it was then recognized that if the cataract were admitted as a factor in the production of the glaucoma, the correct treatment of the latter neces-

sitated the prompt removal of the lens. This was done with combined iridectomy in a considerable number of cases, with very satisfactory results upon the whole. Where possible, the tension was reduced by eserin beforehand. But in the majority of cases the tension was still high at the time of the cataract extraction. It was considered that the danger of intraocular hæmorrhage was probably slight in these eyes, owing to the glaucoma being usually of quite recent origin, and being, partly at least, secondary. It was thought that the changes in the blood-vessels were probably not marked. We have, however, met with two cases of expulsive hæmorrhage in such eyes, and we had another unsatisfactory result from large prolapse of iris and of vitreous (without loss). Hence latterly we have always reduced the tension before removing the lens. In some cases eserin has sufficed for this. In other cases I obtained a lasting reduction in tension by a form of subconjunctival paracentesis. Thus I have been able to wait for two or three weeks, if necessary, for the congestion of the eyes to subside mainly or entirely before operating upon the lens. I have preferred this to preliminary iridectomy because of our unfortunate early experience of iridectomy in these cases, above mentioned. One feels that should the anterior chamber remain empty in these congested eyes, there is every opportunity for consolidation of adhesion between the base of the iris and the periphery of the cornea, closing the filtration angle permanently, and ensuring the return of plus tension. By the paracentesis which I have performed the tension has been reduced though the anterior chamber has not remained empty. Hence its superiority here over iridectomy. A small tongue or flap of cornea and sclerotic is isolated, with its base at the corneal margin, thus. Selecting a site preferably upwards and outwards, a very narrow Graefe's knife,

slightly less than 1 millimetre in width, is inserted through the sclerotic at a distance of about 1·5 millimetres from the corneal margin, into the angle of the anterior chamber. The puncture is made subconjunctivally by sliding the conjunctiva. The blade is introduced parallel to the iris, and a small incision made 1·5 to 2 millimetres long. Then at each end of this small section the edge of the knife is turned forwards, and with slow sawing movements a small subsidiary incision made as far as the corneal circumference. The whole is subconjunctival, as the conjunctiva is raised by escaping aqueous. The sawing movements with the back of the blade pressing on the iris, the anterior chamber being empty, may be painful. For this reason, and also to avoid unnecessary hæmorrhage, adrenalin is

Fig. 95.—Modified Paracentesis.

instilled beforehand with the cocain, and the cutting is done mostly or entirely in the withdrawal movements of the knife. It is uncertain yet how long these small incisions drain. Some at least appear to leak permanently. It is necessary to keep the pupil under the influence of eserin afterwards, to prevent adhesion of the iris to the wound.

A causal relationship between cataract and glaucoma exactly the reverse of the above is frequently seen. In India cataract, as a result of primary glaucoma, frequently comes on sufficiently early to reduce what would be otherwise useful vision. It is not, however, sufficiently ripe to permit of extraction at the time when operation is demanded for the high tension. It may be expected to

go on developing slowly after the glaucoma has been relieved, and may need extraction months or years later.

The chance coincidence of cataract and early glaucoma in the same eye is seen at times. The absence of etiological relation between the two may be assumed with the forms of cataract that lead to no shallowing of the anterior chamber. Incipient cataract and incipent glaucoma are seldom seen together, probably because most lenses in the early stage of cataract formation are reduced in volume. I have notes of a few cases of glaucoma developing together with hypersclerosis of the lens; these lenses are probably not smaller than normal. Supposing operation for the reduction of tension has failed, one may feel tempted to extract an unripe cataract to get rid both of the tension and opacity. The only two cases in which I operated thus turned out badly.

CATARACTS SECONDARY TO IRIDO-CYCLITIS,

with occlusion of pupil, and often with total posterior synechiæ (*cataracta accreta*), may give good results if the eye be not softened and if the projection of light be fair. The cataract may not be detected until an artificial pupil has been made, and after the lens extraction there may possibly be a third operation required for membranous opacity. This is rather tedious. If it seems very probable that cataract is present—*e.g.*, in old dense occlusion,* or if the lens can be partly seen through thin pupillary mem-

* It is, as a rule, scarcely too much to assume that in old dense occlusion of pupil a fairly ripe cataract is present, and that it is fit for extraction if the tension of the eye be fair and the projection of light good. But in one patient, aged thirty-two years, acting on this assumption, I made a large incision unnecessarily, and lost some vitreous. The lens had become absorbed. A simple free incision of the remains of iris, capsule, and inflammatory tissue would have been sufficient.

brane—the operation for extraction may be combined with an iridectomy upwards. And in some cases opaque capsule may be removed at the same time. It is surprising how readily the capsule comes away from its old adhesions to iris,* whose tissue may now be more or less atrophied and friable. Proceeding thus in the one operation, but step by step, I have had unexpectedly good results. The number of cases has, however, been very small.

In **Wenzel's Method**† the knife, while making the corneal incision, passes through iris and often through the ns capsule, a portion of these matted membranes being afterwards cut away with de Wecker's scissors. This mode of operating may be almost forced on one by a very shallow chamber, and is perhaps preferable when there is much matting together of iris and lens capsule.

I have only operated thus in three glaucomatous eyes, where there was no occlusion of pupil nor any past iritis, but merely very shallow chamber. Unless the chamber is very shallow, aqueous must be allowed to escape as soon as the puncture has been made, to bring the lens and iris forward. Unless the chamber be nearly emptied, the capsule of the lens may escape division in the making of the section. The equator of the lens must then be forced forward to the wound by pressure on the cornea below, for incision of the capsule along the whole length of the wound by the cataract knife. Where there is a firm diaphragm made up of iris, lens capsule, and inflammatory membrane the blades of de Wecker's scissors may have to be introduced into the eye after the expulsion of the lens, to excise a portion of the combined membrane. Two converging

* However, in one case I tore iris away from its base below. The coloboma made above became closed, but the patient counted fingers at 8 feet with lens through the gap below.

† 'Manuel d'Oculistique,' i (Paris, 1808), 120.

cuts are made, one scissor-blade being passed in front of the membrane and the other behind it.

REMOVAL OF THE TRANSPARENT LENS IN HIGH MYOPIA.

The scope of this volume does not include the consideration of the operative treatment of high myopia. The treatment here claims our interest merely with regard to the various methods of extraction practicable alike for transparent lenses, and for lamellar and other partial stationary cataracts—their relative advantages and risks, and their bearing upon cataract work generally. The patients being mostly young, linear extraction is commonly applicable. And this is usually preceded by discission, to soften and to loosen the lens substance, and followed by discission for after-cataract.

Though opacification and loosening of the posterior layers may often be obtained by slow cataract formation from very limited discission, repeated once or twice if necessary, yet owing to the tediousness of the process and to the difficulty experienced in regulating it so as to avoid the complications, plus tension and irritation of the iris, many surgeons find it preferable to secure rapid breaking up of the lens by very free needling. The complications are prevented or forestalled by the use of iced applications and rest in bed, and by early extraction. Others advocate primary linear extraction, with later discission of after-cataract (Weber, Hess, Sattler); others primary flap extraction (Vacher, Fukala, Hirschberg).

High tension from swelling of the lens is not in itself a very serious matter. It causes trouble, however, by necessitating extraction of the lens—necessarily very incomplete—before the ripening process is sufficiently advanced, and

while the eye is painful and irritable. General anæsthesia may be required on this account, and afterwards the congested iris may not respond to the instillation of atropin.

For the wide opening of the capsule at the preliminary discission, either a single long cut or a crucial division is made. And the lens is rather deeply incised. Some operators use a Graefe's knife for this. Emmert* breaks up even the nucleus and the posterior layers of the lens with a very broad discission-needle. It is considered wise to avoid allowing the aqueous to escape, lest the pupil should thereby contract, and the iris form adhesions to the torn capsule. Mooren, however, combined massage of the lens with discission.

At the linear extraction the capsular opening is still further enlarged if not already very wide.

For primary extraction of the transparent lens Sattler† makes an incision 6 to 8 millimetres long, 1·5 to 2 millimetres within the upper corneal margin, with Weber's curved keratome (p. 26). He introduces a sharp iris hook, and makes first a horizontal slit in the capsule behind the lower margin of the widely dilated pupil, and from that tears freely the whole of the anterior capsule. Then, with the back of the hook, he loosens the lens substance from the equatorial and posterior portions of capsule, and proceeds to evacuate the lens by depression of the peripheral lip of the wound with a Daviel's curette, together with external spoon pressure about the lower corneal margin. The nuclear portions of lens matter are first expressed. Two-thirds or three-fourths of the lens matter are thus removed, and atropin is instilled. The remainder left behind is insufficient to give rise to high tension by swelling. If the iris enters the wound during the operation it is replaced. Discission of the posterior capsule and lens débris, practised after a week or so, "is sufficient to obtain a clear pupil in a fortnight or little more." He considers that preliminary discission should be given up entirely.

Axenfeld‡ and Gelpke§ remove the anterior capsule with

* *A. f. A.*, lv (1903), 2, 358.
† *Ber. der* xxvii *Vers. der ophth. Ges. zu Heidelberg*, 1899, S. 207.
‡ *Kl. Mbl. f. A.*, xli (1903), 1, 60.
§ *A. f. A.*, xlix (1904), 2, 152.

forceps to obtain the widest possible opening, and so to reduce the need for treatment of after-cataract. Emmert extracts the lens twenty-four hours after the free needling which he practises. Though after this early extraction often a considerable time is taken up in the absorption of lens remnants, he has found discission for after-cataract nearly always unnecessary. The avoidance of any interference with the posterior capsule is a matter of importance in these highly myopic eyes, having regard to the danger of causing detachment of the retina by displacement of vitreous. And the risk of post-operative glaucoma is thus reduced also.

In order to lessen existing astigmatism, the incision has been sometimes placed at right angles to the meridian of greatest corneal curvature.

Rogman* prefers suction to ordinary linear extraction.

Primary linear extraction necessitates a larger section than suffices for evacuation of lens substance after free discission; hence possibly a slightly greater risk of infection and of prolapse or incarceration of iris.

Should there be adhesions of vitreous or capsule to the corneal scar after linear extraction, Senn† divides the adherent tissue, lest the pull upon the vitreous should lead to detachment of the retina. Sattler had vitreous loss in 20 per cent., Schweigger in 10 per cent., and Pflüger in 10 per cent. of their extractions. Detachment of retina occurred in 4·34 per cent. of Sattler's cases, in 14 per cent. of Schweigger's, and in only 1 per cent. of Pflüger's. The latter operator practised discission of after-cataract in more than half of his cases. Thus his experience is that this discission does not lead to retinal detachment.

In patients over thirty-five years of age primary flap extraction of the transparent lens is commonly preferred, followed, if necessary, by discission. Linear extraction after preliminary needling is, however, practised by some operators in older patients, since often in these highly myopic eyes there is not a large, hard nucleus. But one cannot be sure of the condition of the nucleus beforehand, and in these older patients

* *Ann. d'Ocul.*, cxxi (1899), 1. † *A. f. A.*, xliii (1901), 241.

the needling frequently causes reaction. To lessen the risk of exciting high tension, the discission has been sometimes combined with an iridectomy.

DISLOCATED LENSES.

A. In the Anterior Chamber.

Replacement of the lens through the pupil has been practised occasionally. It seems applicable only to lenses spontaneously dislocated, which are often shrunken, and have lain formerly subluxated behind the iris without causing irritative symptoms, and may still retain their connexion with stretched zonule.

The most suitable and safest extraction is by Czermak's lower subconjunctival method. The lens occupying the lower portion of the chamber is then quite close to the section, which can be made with scissors without displacing the lens. And there is little risk of loss of vitreous. This risk constitutes the chief danger and difficulty with other incisions. Should the lens have lain long in its abnormal position, however, it may have become fixed to the cornea, rendering a lower section difficult and only to be accomplished by transfixion or displacement of the lens. In India a considerable proportion of the patients came for treatment only when sight had been lost by secondary glaucoma caused by the luxated lens. Operation was merely for the relief of pain. In these eyes loss of vitreous mattered little, and the ordinary upper section sufficed.

In making the ordinary section vitreous may begin to escape even before the incision is completed, especially if there be high tension. Desmarres' retractor should be used for the upper lid, and finger depression for the lower lid, instead of the stop-speculum. The upper portion of the lens may lie in the path ordinarily taken by the knife

in making the section, or possibly the upper part of the iris may be pressed forward against the cornea by vitreous tension. In an eye in which the attainment of useful vision is still possible, it is important not to risk displacement of the lens backwards by transfixion with the knife. There is always room for an incision of moderate extent, made in the usual way with a very narrow Graefe's knife, 1 millimetre or less; and this may be enlarged, if necessary, with scissors. If the upper part of the anterior chamber be extremely shallow, the iris must be cut with the knife, or the section might be begun by sawing from in front, as was done by Spencer Watson,* in 1871, with a scalpel. Some operators have preferred linear extraction by outer section, the point of the keratome being thrust behind the lens. And Müller recommends his operation (p. 201) for dislocated lenses. The lens is removed with a loop or spoon.

The instillation of eserin beforehand is indicated† in order that the lens may be supported by the iris and prevented from slipping backwards through the pupil. There is then no need for the very inconvenient fixation of the lens by transfixion with a needle, or for operation with the patient in the semi-prone position—methods which have been adopted.

The instillation of adrenalin before or with the cocain is advisable in all cases, and especially necessary in painful eyes, to ensure quietness‡ so far as possible.

* *The Practitioner*, 1871, p. 271.

† According to Eversbusch (*Vers. der ophth. Ges. zu Heidelberg*, 1878), eserin instillation is inadmissible before operation for a congenitally ectopic lens, still attached to an elongated zonule. The pull on the zonule caused by myosis may draw the shrunken lens back into the posterior chamber.

‡ In one of our operations upon a dislocated lens adherent to the cornea—a shrunken lens which evidently had been Morgagnian, but from which all the fluid had been absorbed—its detachment from the cornea with the spoon caused pain sufficient to excite spasm of orbi-

B. In the Vitreous.

I have no experience of extraction of lenses dislocated into the vitreous. It would be undertaken only if sight were being lost through high tension or other complication due to the displaced lens. Smith of Jullundur has removed many dislocated lenses with a spoon or by simple expression, but gives no details. Possibly in his cases the lenses had resumed their normal position.

Should the lens lie quite free in the vitreous, it may be possible to bring it into the anterior chamber merely by dilating the pupil and placing the patient in the prone position. Euphthalmin and cocain are recommended as mydriatics. Should this succeed, the prone position is maintained while myosis is obtained by eserin, and the lens is then extracted.

Often the lens retains some connexion with the ciliary body either by means of zonule or by bands of new tissue. It may then lie quite close to the iris. Knapp* has succeeded in delivering such lenses, with little or no loss of vitreous, mainly by external pressure—finger pressure applied below through the lower lid. A speculum is used only for the making of the section. This is upwards, the summit of the flap being placed 2 millimetres within the corneal margin. The final delivery is aided by the introduction of a spoon by the assistant.

Von Graefe and von Arlt have succeeded in piercing more deeply placed lenses with a needle through the sclerotic, and so bringing them up into the pupil or into the anterior chamber for removal with a spoon or loop. Agnew's 'bident'† has been used similarly for bringing lenses up for extraction—lenses which are too freely movable to be readily pierced by a needle. The bident consists simply of two straight needles fixed in a holder parallel to one another, $\frac{1}{8}$ inch apart. The two needles are passed into the vitreous behind the lens, and are swung forward supporting the lens.

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cularis. Thus there was a considerable loss of vitreous. Cocain alone had been instilled. If it had been combined with adrenalin, possibly the accident might not have happened. The visual result of the operation, however, was good—at least, while the patient was under observation.

* *A. f. A.*, xxii (1890), 171.

† *Trans. Amer. Oph. Soc.*, 1885, p. 69.

C. Subluxated Lenses.

1. *In the Pupil.*—Spontaneously displaced lenses in this situation are more or less shrunken lenses, either ectopic or merely the nuclear remains of Morgagnian cataracts, lying in collapsed capsule. In the case of the larger lenses, and therefore particularly in traumatic displacement, treatment may be demanded for the relief of secondary glaucoma.

Possibly by the use of a weak mydriatic and forward bending of the head, further displacement of a shrunken lens into the anterior chamber may be secured. And after sufficient eserin instillation to fix the lens there, it may be extracted. Otherwise operation must be undertaken with the lens still lying in the pupil. Czermak's subconjunctival, also L. Müller's and Bourgeois' sections, have each been recommended. It is suggested, also, to place the section at that portion of the corneal margin towards which the lens margin points, in order that a spoon or loop may the more readily be introduced behind the lens. If the small lens lies loosely in the pupil, it may be fixed by a needle passed in through the sclerotic.

2. *In the Posterior Chamber.*—Here, again, there may be high tension, or operation may be advisable on account of double vision or cataract formation. In cataractous cases without plus tension an optical iridectomy, sphincterectomy, or iridotomy may give a fair visual result. The iris may be difficult to seize with forceps, but may be drawn out with a hook.

In children repeated discission may be preferable to extraction. On account of the mobility of the lens, it may be difficult to make a large enough opening in the capsule in discission, and there is some risk of displacement of the lens backwards into the vitreous. For this reason Eversbusch opened the capsule with a cystitome introduced through a peripheral corneal puncture.

Zion* recommends transfixion of the lens with a needle introduced from behind through the sclerotic to prevent its displacement during discission by a second needle introduced through the cornea.

Linear extraction after discission is inapplicable because of vitreous in the anterior chamber. Terson recommends aspiration with Bowman's syringe.

* *Ophth. Klinik*, iii (1899), 121.

In older patients extraction of the lens in its capsule is indicated, with loop or spoon, or, if the capsule be thickened and opaque, with forceps. L. Müller's or Bourgeois' section might be made. In one case of traumatic subluxation downwards I found the lens firmly adherent below. Only partial removal was possible. A good deal of cortex was left and much vitreous lost, and the resulting vision was worse than before operation.

Where operation is required on account of double vision, further lateral displacement of the lens with a needle may suffice.

In a case of ectopia lentis with congenital coloboma and small cornea, the fellow eye was useless, and the patient could count fingers at 3 feet with a +6 D lens. Though the lens was opaque, I refused operation, fearing the loss of vitreous.

THE EXTRACTION OF SOFT CATARACT.

Operation for the removal of soft cataract—*i.e.*, opacity in lenses which have not yet developed hard nuclei—is performed mostly upon lenses which have been rendered more or less completely cataractous by discission. The treatment is usually for partial stationary cataract, most often lamellar, or for the removal of the transparent lens in high myopia. In other cases operation is needed for traumatic cataract, or for ripe or overripe general cataract in young persons. Extraction must, however, be rejected in favour of repeated needlings of cataract in young people if the cataract be complicated, and if at the same time the tension of the eye be at all reduced, also possibly in very high myopia. Traumatic cataract in my experience has been practically always met with at an age when the lens was still fairly soft throughout. There is often inflammation, infective or otherwise, which may render considerable delay in operative interference advisable. The delay is until the eye has become normally pale, and remains so

after moderate friction through the lids. Operation may be deferred also because of unripeness of the cataract. But at other times early interference is necessary on account of high tension excited by the swollen and disintegrating lens. This compulsory removal of lens matter is sometimes a supplement to discission. And it is often only a very partial operation, much unripe, sticky lens substance being unavoidably left behind. In other cases extraction is an expeditious alternative to the very tedious, but on the whole safer, absorption of the lens under repeated needlings.

The operation is known as *linear extraction* (Lanzen-extraction), or 'curette evacuation.' It may sometimes

Fig. 96.

Fig. 97.

Linear Extraction.

be applicable for traumatic cataract in people over thirty-five years of age. Where the lens has been penetrated deeply, the nucleus may become softened and broken up.

The pupil having been dilated widely, if possible, a nearly straight incision, 5 to 10 millimetres long is made in the cornea with a triangular lance-knife or keratome The shorter section (with a comparatively narrow blade) is made in infants, and also in older patients if the cataract is fully ripe or overripe. It is placed usually 1 to 1·5 millimetres within the corneal margin. If the capsule of the lens has not been opened previously, it is opened freely now with a cystitome. If the cataract is fully ripe, depression of the peripheral lip of the wound with a curette should enable most of the soft lens matter to escape, with-

out injury to the iris. The material may also, if necessary, be pressed out by stroking movements over the cornea with a tortoise-shell spoon or other expressor, the globe being fixed by the assistant. The curette may also be inserted a little way into the chamber to break up and to withdraw some of the lens substance. And it is recommended sometimes to wait for the re-accumulation of a little aqueous, and to practise repeated reinsertion of the curette. (The instrument must be cleansed before each reinsertion.) If iris prolapses early, it may have to be excised, but generally replacement suffices.

The position of the section and other details of the operation vary with the ripeness of the cataract. If it is fully ripe, the incision may be placed in the outer part of the cornea. This is an advantage in young children, as it permits of the operation being completed without a general anæsthetic, the patient not being required to look down. But if it is anticipated that a portion of the lens is still incompletely cataractous, the incision should be placed above. Probably an iridectomy will be required to facilitate the evacuation of the chamber, and because of bruising of the iris during the manipulation. Iridectomy may also be required on account of posterior synechiæ. The removal will probably be incomplete, and therefore the wound may be left occupied by shreds of translucent cortex. It may be impossible to clear these shreds out of the incision, where they constitute a grave danger, possibly serving for the admission of infective organisms. Therefore the wound should not only be above, but it should be in the limbus and subconjunctival. (The conjunctiva should be pushed down a little on the point of the keratome.) I have preferred to make such a section with a narrow Graefe's knife, 1 millimetre or less in breadth. Thus the incision can be lengthened a little if desired.

That is, a very shallow flap section may be made instead of the so-called linear section.

Irrigation is often a great help in the removal of cortex, especially when alternated with external pressure, and with introductions of the curette to break up the lens matter. It is, however, better to leave much of the lens behind, and to trust in atropin and mercury afterwards, than to continue in prolonged efforts at removal. A very partial evacuation suffices for the reduction of high tension. In the case of a very overripe cataract opaque capsule may have to be extracted in part or whole. Iris forceps are commonly suitable.

As a small modification, the lens capsule may be opened with the point of the keratome. But the opening thus made may be too small, and if the lens happens to be very thin the posterior capsule may be punctured. The keratome may also be used instead of the curette for depressing the lip of the wound, but care must be taken in this again to avoid the posterior capsule.

Where a general anæsthetic is required, much less of it need be used if local anæsthesia with cocain alone, or with cocain and adrenalin, is utilized also.

Complications.

1. Iris prolapse is rare after this operation because of the slight tendency to gaping of the section, and because iridectomy is often performed at the time of the extraction.

2. Vitreous may prolapse during operation through puncture of the posterior capsule with the point of the knife, or in breaking up lens matter with the curette, or owing to the extraction of opaque capsule, or possibly, in cases of traumatic cataract, through the injury already sustained by the eye.

3. Unripe lens matter left behind may give rise to

trouble, either alone or adding to the work of infective organisms.

4. Infection may be introduced through a purely corneal wound, kept open by shreds of lens substance, by capsule, or by vitreous.

In India we meet fairly often with a class of patient for whom neither extraction nor simple discission is quite applicable. The patients are children with overripe cataracts dating generally from infancy. There is usually much irregular anterior capsular opacity, and enclosed in the sac is only a thin layer of milky fluid, sometimes with a few small flakes of cortex or granular débris. What is required is discission, plus evacuation of the fluid and cortical remains. A wide and satisfactory opening in the opaque membrane can be secured by the use of two Bowman's stop-needles. But if any of the turbid fluid be left behind, there is a liability to an acute glaucomatous attack setting in within a few hours. We found this by experience, and we found that relief of the tension followed at once upon evacuation of the chamber through a small puncture. The complication was afterwards prevented by removing the fluid completely immediately after opening the capsule. This is done by a subconjunctival puncture at the limbus with a narrow (1 millimetre) Graefe's knife. Even with the eye soft from leakage through needle punctures, the narrow knife can be introduced without much pressure. The puncture is enlarged to about double the width of the blade, and the latter rotated in the wound, and the iris pressed a little backwards until the milk leaks gradually away. The knife is passed in front of the iris to the neighbourhood of any milky or granular remains, and then by intermittent jerky pressure serves as a director for the gradual passage outwards of the material. If by

chance both layers of capsule are punctured by the needles so that vitreous is a little displaced forwards, this interferes but little with the evacuation, though it may delay it a little. It is very satisfactory to note how patient continuance of the jerky pressure upon the iris gradually directs piece after piece of soft cortex along the blade and through the puncture. Chloroform is seldom needed even in young children, if the head be held firmly. There is practically no pain. The assistant fixes the eye and rotates it for the insertion of the needles.

Linear extraction of the opaque capsule and of its contents is quite unsuitable at the early age of most of these patients, even with a subconjunctival wound. Vitreous is almost sure to enter the wound, and the healing of the latter is further interfered with by rubbing the eyes and by contraction of the lids, thus predisposing to infection.

SUCTION (ASPIRATION) OF SOFT CATARACT.

A brief reference is due to the removal of soft lens matter through a linear wound by suction, a method known of old to the Arabs and Persians, and associated in its later development with the names of two Englishmen. Teale's * cannula for suction by the mouth and Bowman's pump for instrumental aspiration have been very generally used. The method—recommended by Terson (père) for subluxated traumatic cataracts in young subjects, and advantageous in quite young children, owing to the small size of the incision (less than 5 millimetres) required—has fallen into disuse, apparently from its very limited field of usefulness. In older patients it offers no especial advantages. Owing to the liability of the cannula to become blocked, it is suitable only for quite ripe cataracts, which are readily removable without suction. In suction by the mouth—the older method—the degree of force employed could be regulated to a greater nicety. And very

* *R. L. O. H. Rep.*, iv, 2, 197 ; and *The Lancet*, 1880, i, 29.

slow removal of the lens matter was insisted upon to prevent complications, such as bleeding from the iris, indrawing of iris into the opening of the cannula, rupture of posterior lens capsule, and presentation of vitreous. The tough capsules of some congenital cataracts, insufficiently opened, and therefore not easily penetrated by the cannula, sometimes led to displacement of the lens. The capsule was sometimes opened by preliminary discission, at other times by the broad needle or keratome, after the making of the small corneal section. Subsequent infective inflammations were probably attributable to want of sterilization of the instruments employed.

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